

# 410B DC Power Supply

## Instruction Manual

P/N 294009  
December 1965



# WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.
2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

## SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

## CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

\*For European customers, Air Freight prepaid.

**John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206**

## Change/Errata Information

Issue No: 4 6/79

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's pcb revision letter is equal to or higher than that which is indicated at the beginning of the change.
2. No revision letter is indicated at the beginning of the change/errata.

### MANUAL

Title: MODEL 410B HIGH VOLTAGE DC POWER SUPPLY  
Print Date: DECEMBER 1, 1965  
Rev and Date: -----

### C/E PAGE EFFECTIVITY

| Page No. | Print Date |
|----------|------------|
| 1        | 11/77      |
| 2        | 2/78       |
| 3        | 6/79       |

## ERRATA #1

On page 2-2 paragraph 2-7e, change CAUTION note to read as follows:

## CAUTION!

The sample string resistors in the 410B are subject to damage if the output voltage is reduced too rapidly. Pause approximately  $\frac{1}{2}$  second in each switch position when reducing the setting of the first decade switch (1000 volt increments). The second decade should be set to 300 or greater or the HIGH VOLTAGE switch set to STANDBY RESET before the first decade is set to 0 (zero).

## CHANGE #1-3091

On page 5-10, remove Q204 from Ref Desig group Q203 and Q204 and add it to group Q205 and Q206 (use Code D). Change the tot qty of Q203 from 3 to 2. Change the tot qty of Q205 and Q206 from 2 to 3.

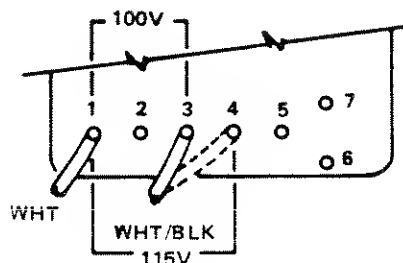
## CHANGE #2-6647

On page 5-9 delete the entire C215 entry and add the following new entry:  
C215; Cap, optional or factory selected.

## CHANGE #3-6720

On page 1-1, delete information under "INPUT POWER" and add: 100/115/230V ac, 50 to 500 Hz, approximately 300 VA at full output.

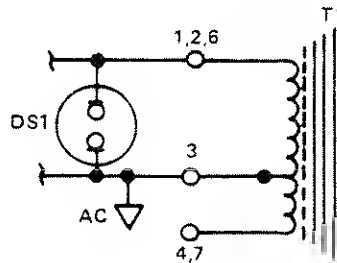
On page 2-1, delete information under paragraph 2-4 and add: Two power transformers (T1) are available for this instrument, 100/115V ac or 115/230V ac. On the rear panel of each instrument a decal indicates the operating voltage of the transformer installed. This operating voltage can be changed by altering the wiring configuration of the transformer. To change the operating voltage of the 115/230V ac transformer, refer to the decal located on the power transformer. Refer to the drawing below for changing the operating voltage of the 100/115V ac transformer. To gain access to the power transformer, remove the instrument's top cover and the Delay PCB Assembly.



On page 5-3, add after T1 description: (115/230V). Add another listing for T1 as follows: T1; Transformer, Aux. (100/115V); Stock No. -5600-350918; Mfr. -89536; Mfr. Part No. -5600-350918; Tot. Qty. -1.

On the schematic diagram, add, as a separate note, the following primary configuration of T1 for the 100/115V ac power transformer.

Transformer connections shown are for 100V ac operation. For 115V ac operation, move the wire at terminal 3 to terminal 4 or 7.



#### CHANGE #4-7609

On page 5-10, change the stock no, mfr, mfr part no, and tot qty for transistors Q211 and Q212 from:  
4805-203489, 07910, CDQ 10656, REF  
to:  
4819-168716, 07263, S19254, 2

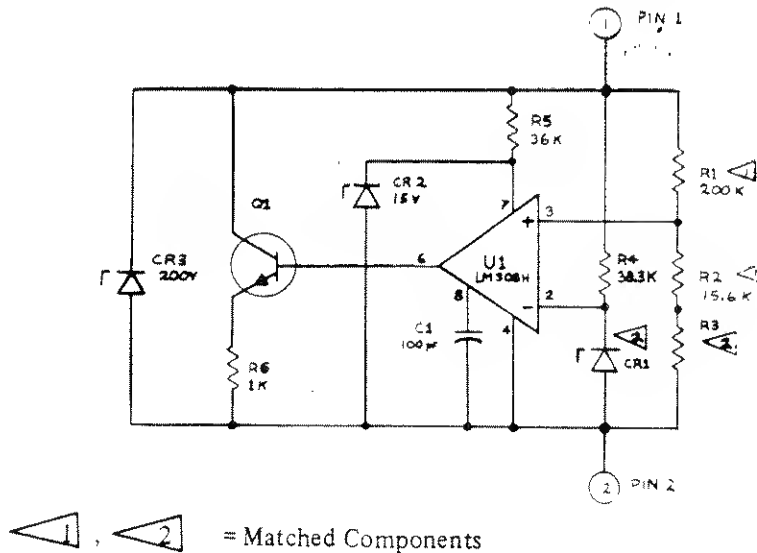
#### CHANGE #5-8438

On page 5-7, add the following new entry:  
R155; Res, comp, 1.3k  $\pm$  5%,  $\frac{1}{2}$ W; 4704-109157; 01121; EB1325; 1.

#### CHANGE #6-415-1030

On page 5-11, add the following replacement for voltage reference 83A1 (V201).  
V201, 83A1 Substitute PCB, 451047, 89536, 451047.

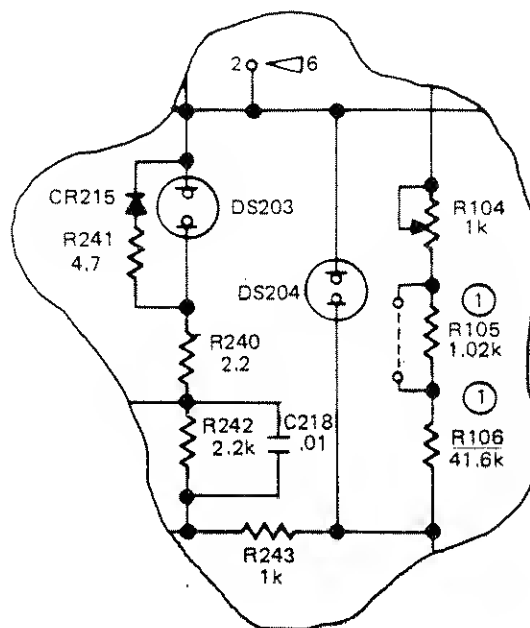
On the schematic, remove and replace V201, R219 and R220 with the reference substitute shown below. Connect pin 1 to junction of R221 and base of Q206. Connect pin 2 to junction of DS203 and R141 (0V).



## CHANGE #7 – 11910

Rev. -G, Amplifier PCB Assembly

On the Functional Schematic (High Voltage Power Supply) make the following changes:



ADD: DS204

## CHANGE #8 – 12060

Rev. -H, Amplifier PCB Assembly

On page 5-10, make the following changes:

FROM: Q211/Transistor, NPN, Si/4819-168716/07263/519254/Ref

TO: Q211/Transistor, NPN, Si/4805-203489/07910/CDQ10656/Ref

## CHANGE #9 – 12329

Rev.-B, Front Panel Assembly (410B-406)

On page 5-6, make the following changes:

FROM: Handle, 6-7/16"/2404-101584/05704/805/2

TO: Handle/2404-494989/88245/1061-29/2

## ERRATA #2

On page 1-1, under ELECTRICAL, add the following information:

Protection Class . . . . . #1 (Relates solely to insulation or grounding properties further defined in IEC 348.)

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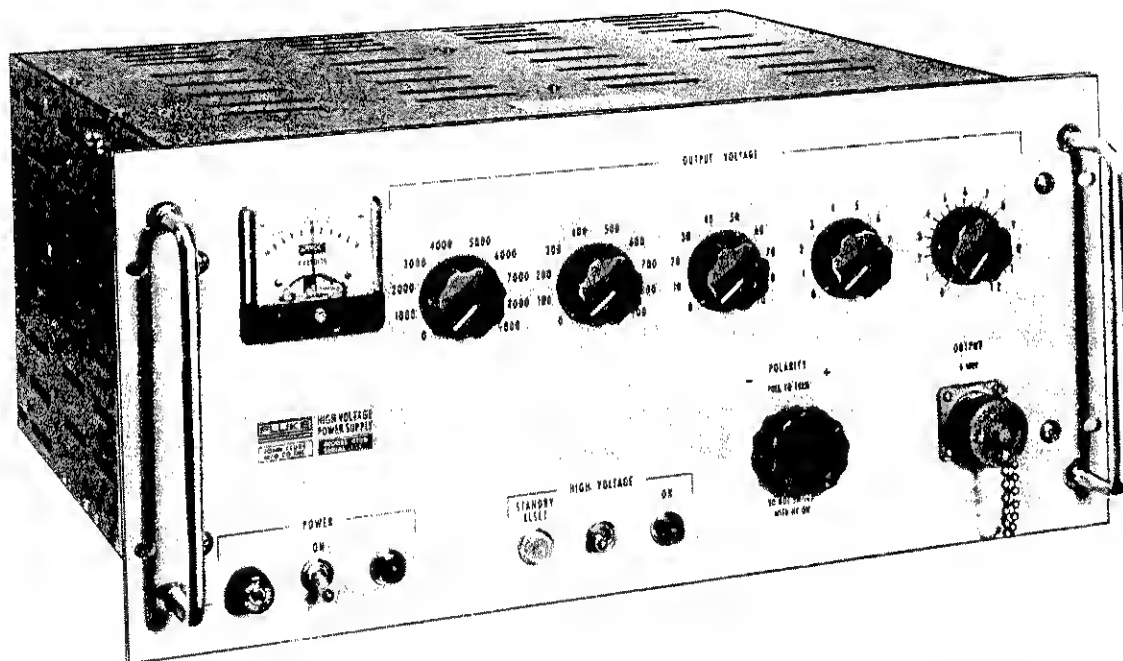
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MODEL 410B HIGH VOLTAGE DC POWER SUPPLY

## SECTION I

# INTRODUCTION AND SPECIFICATIONS

### 1-1. INTRODUCTION

### 1-2. GENERAL DESCRIPTION

1-3. The Fluke Model 410B High Voltage DC Power Supply is capable of providing an output of 0 to 10,000 vdc at 0 to 10 milliamperes. The output voltage is selected by four decade switches and a vernier potentiometer. The instrument may be operated with either positive or negative output terminal grounded, as selected by a front-panel switch. Overcurrent protection is provided to return the supply to standby operation in the event of excessive load current.

1-4. The Model 410B is a hybrid design utilizing silicon transistors for the amplifier circuitry and a vacuum tube for the necessary high voltage series passing element. A time-delay relay is incorporated in the input circuitry, which prolongs the life of the high voltage passing tube. The reference element is a highly stable temperature compensated gas tube.

1-5. The package design provides for adequate cooling at high ambient temperatures without the use of cooling fans. Rubber feet are provided for bench top operation to permit unrestricted air flow through the bottom cover air vents. The front panel is punched for mounting in a standard 19 inch rack. Side panels are tapped for Jonathan #130 quick disconnect chassis slides or other rack mounting supports.

### 1-6. RECEIVING INSPECTION

1-7. This instrument has been thoroughly checked and tested before being shipped from the factory. Immediately after receiving the instrument, carefully inspect for damage which may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page in the back of this manual.

### 1-8. SPECIFICATIONS

#### 1-9. ELECTRICAL

OUTPUT VOLTAGE: 0 to  $\pm 10,000$  VDC.

OUTPUT CURRENT: 0 to 10 milliamperes.

OUTPUT POLARITY: + or - grounded via front panel switch.

LINE REGULATION: 0.001% or 2 mv (whichever is greater) for 10% line change from nominal.

LOAD REGULATION: 0.001% or 5 mv (whichever is greater) for full load change.

STABILITY:  $\pm 0.005\%$  per hour;  $\pm 0.02\%$  per day after warmup.

RESOLUTION: 5 millivolts.

RIPPLE: Less than 1 mv RMS; less than 5 mv peak-to-peak.

#### VOLTAGE CALIBRATION:

0 to 9000V in 9 steps of 1000V  
0 to 900V in 9 steps of 100V  
0 to 90V in 9 steps of 10V  
0 to 9V in 9 steps of 1V  
0 to 1.2V vernier

CALIBRATION ACCURACY:  $\pm 0.25\%$  or 250 mv (whichever is greater) with vernier at zero.

RESETABILITY:  $\pm 0.05\%$  or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 30 minutes.

OVERCURRENT TRIP: Set to latch off at 12 ma load current. Internally adjustable from 5 to 15 ma.

METER: 10,000-0-10,000 vdc ( $\pm 3\%$ ).

OUTPUT CONNECTORS: MS3102A-18-16S front and rear (one mating connector supplied).

INPUT POWER: 115/230 VAC  $\pm 10\%$ , 50 - 60 Hz, approximately 300 VA at full output. Operation at 400 Hz available upon request.

#### 1-10. MECHANICAL

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE RANGE:  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ .

STORAGE TEMPERATURE RANGE:  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

ALTITUDE, OPERATING: 0 to 10,000 ft.

ALTITUDE, NON-OPERATING: 0 to 50,000 ft.

VIBRATION: Meets MIL-T-945A.

SHOCK: Meets MIL-E-4970A (20 g's, 11 milliseconds in three principal axis).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per  $^{\circ}\text{C}$  from  $+10^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ .

SIZE: 19" wide x 8-3/4" high x 15" behind panel (rack mount with resilient feet for bench use).

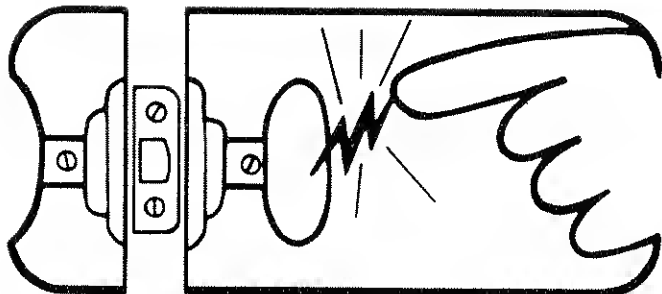
WEIGHT: Approximately 59 pounds.



# static awareness



A Message From  
**John Fluke Mfg. Co., Inc.**

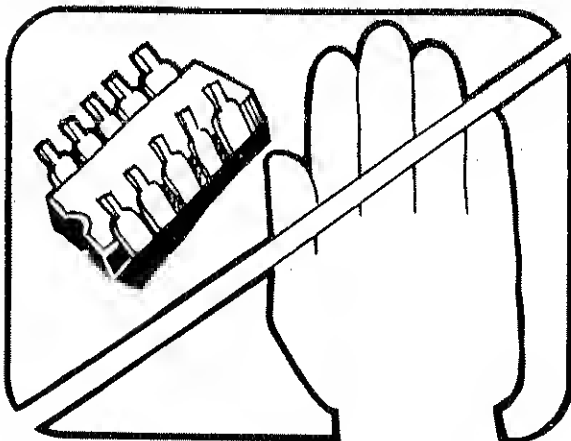


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

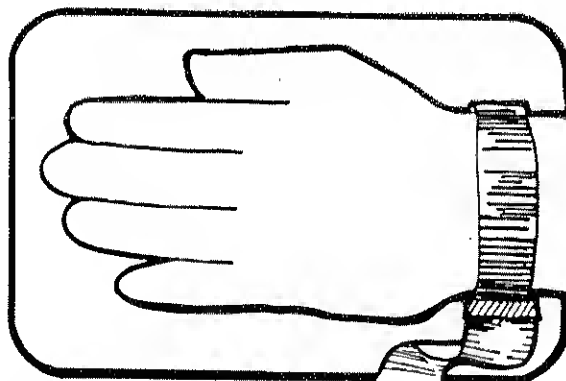
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

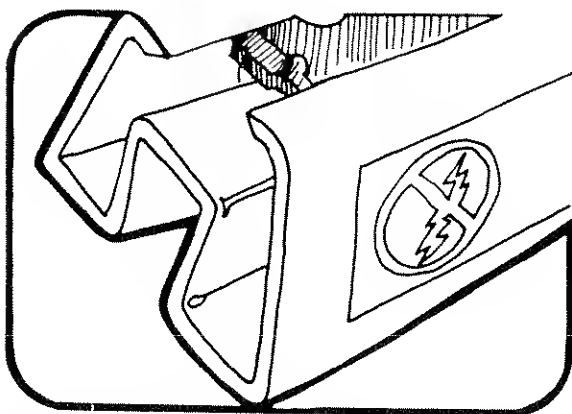
The following practices should be followed to minimize damage to S.S. devices.



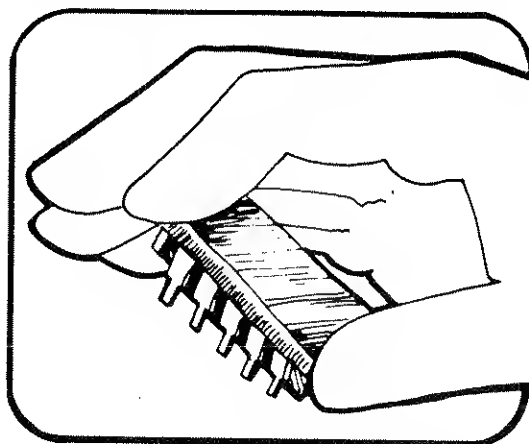
1. MINIMIZE HANDLING



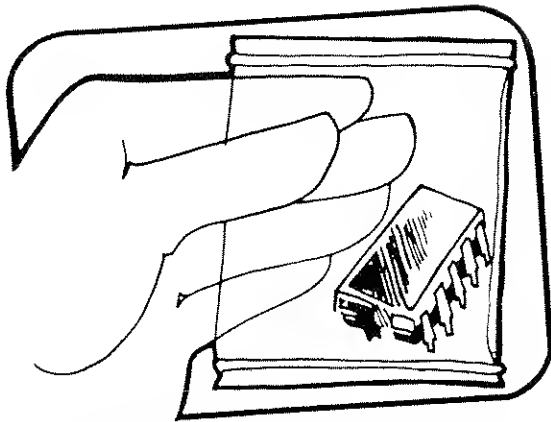
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



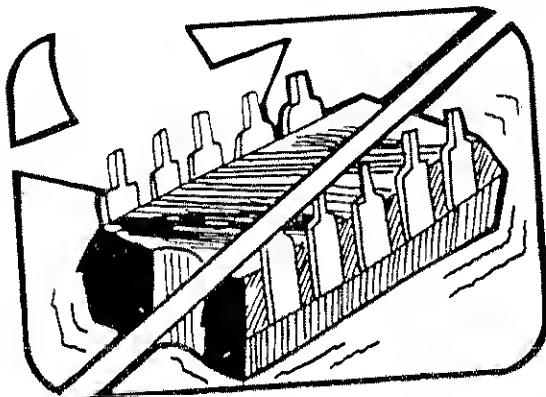
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



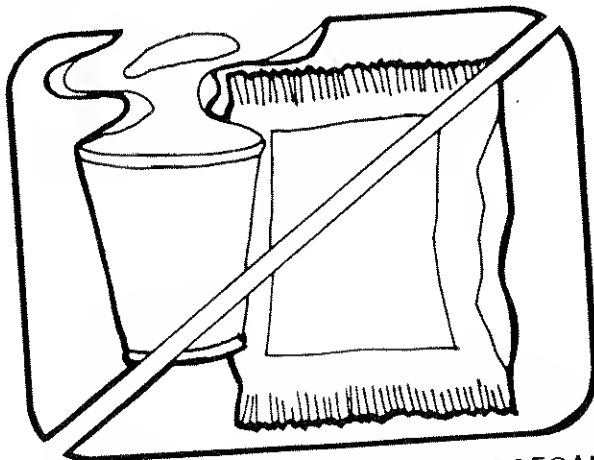
4. HANDLE S.S. DEVICES BY THE BODY



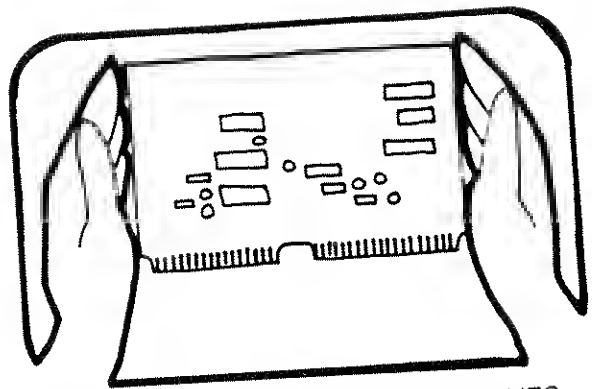
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



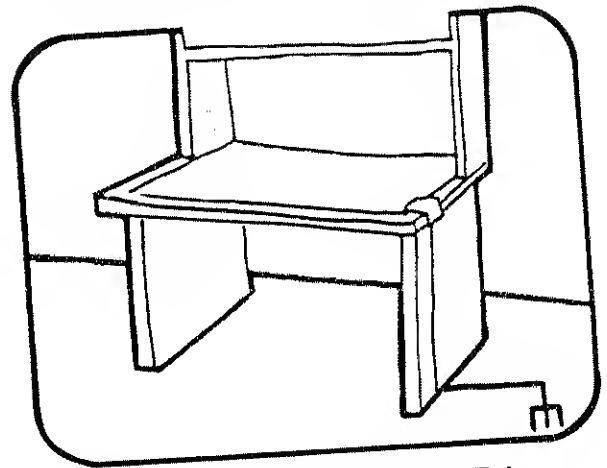
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION  
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.  
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.  
PARTS DEPT. M/S 86  
9028 EVERGREEN WAY  
EVERETT, WA 98204

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## SECTION II

### OPERATING INSTRUCTIONS

#### 2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-2. The function of external controls, terminals, and indicators on the 410B is given in Figure 2-1.

#### 2-3. INPUT POWER

2-4. Input power to the 410B is 115 vac or 230 vac ( $\pm 10\%$ ), at a frequency of 50 to 60 Hz. Instruments are

supplied for operation from 400 Hz when requested. The 410B is equipped with dual primary windings on transformer T1, which are usually connected in parallel for operation from 115 vac. When requested, instruments are wired with the primary windings connected in series for operation from 230 vac. If it becomes desirable to change from one operating voltage to the other, remove the top cover of the instrument, and change the jumper wires and the fuse as shown on the transformer decal.

| CONTROL<br>TERMINAL, OR<br>INDICATOR | LOCATION                 | REFERENCE<br>DESIGNATION  | FUNCTION   |
|--------------------------------------|--------------------------|---------------------------|--|
| POWER<br>switch                      | Front panel              | S1                        | Applies line power to the control circuit and to the auxiliary transformer.  |
| POWER<br>lamp                        | Front panel              | DS1                       | Indicates the application of line power to the instrument circuitry.   |
| Fuse                                 | Front panel              | F1                        | Protects the instrument against damage due to overload.  |
| STANDBY-<br>RESET lamp               | Front panel              | DS2                       | This lamp illuminates when the time delay cycle is completed when the HIGH VOLTAGE switch is set to STANDBY-RESET.   |
| HIGH VOLTAGE<br>switch               | Front panel              | S2                        | Energizes and de-energizes the primary of transformer T2.  |
| HIGH VOLTAGE<br>ON lamp              | Front panel              | DS3                       | This lamp illuminates when the HIGH VOLTAGE switch is set to ON (after the time-delay cycle is completed), indicating that the high voltage is available at the output connectors. |
| POLARITY<br>switch                   | Front panel              | S7                        | Used to select either a positive or negative output with respect to chassis ground. This switch must be pulled out to turn, which interrupts ac input power to the instrument.     |
| OUTPUT<br>VOLTAGE<br>controls        | Front panel              | S3, S4, S5,<br>S6, & R140 | Switches S3, S4, S5, & S6 select the output voltage in steps of 1000V, 100V, 10V, and 1V, respectively. R140 provides a continuous output of 0 to 1.2 volts.                       |
| Voltmeter                            | Front panel              | M1                        | Indicates the output voltage from -10.0 to +10.0 KV. Accuracy is approximately 3% of end scale.  |
| OUTPUT<br>connector                  | Front and<br>back panels | J1 and J2                 | Provided for connecting the load circuit to the 410B.  |

Figure 2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-5. INITIAL OPERATION

2-6. The following procedure is recommended when turning on the Model 410B for the first time after shipping or a long period of idleness. This procedure will minimize the possibility of accidental damage to the unit.

a. The 410B is shipped with the series passing tube removed from the socket and packed in a carton, which is fastened to the top cover. Install this tube in its socket and connect the plate wire to the plate cap before applying power to the instrument.

b. Connect the line plug to a 115 vac power source (or 230 vac if so wired).

**WARNING**

The round pin on the polarized three-prong plug connects the instrument case to power system ground. If a three-to-two pin adapter is used to connect to a two-contact outlet, connect the short lead on the adapter to a good ground.

Always cover the unused output connector with the cover provided to prevent accidental contact with the high voltage, and dirt accumulation on the connector.

c. Set the HIGH VOLTAGE switch to **STANDBY-RESET**.

d. Set the POWER switch to **ON**. The POWER lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the **STANDBY-RESET** lamp will illuminate.

**CAUTION**

The 410B is designed for convection cooling without the use of fans. For bench top operation, the rubber feet must be installed or other steps taken to ensure adequate spacing for unrestricted air flow through the vents in the bottom cover.

e. Set the second OUTPUT VOLTAGE dial to 500.

f. After the **STANDBY-RESET** lamp illuminates, set the HIGH VOLTAGE switch to **ON**. Carefully observe if the HIGH VOLTAGE lamp illuminates and if the output voltage rises to within 3% of 500 volts as indicated by the panel meter.

**CAUTION**

If the output voltage exceeds approximately 500 volts, immediately set the HIGH VOLTAGE switch to **STANDBY-RESET**.

g. If the output voltage is 500 volts, the supply may be operated as in paragraph 2-7 or 2-8. If the output is not 500 volts, perform steps h. through j.

h. Set the HIGH VOLTAGE switch to **STANDBY-RESET**.

i. Locate and correct the source of trouble. Refer to Section IV.

j. Repeat the initial operating procedure.

2-7. GENERAL PURPOSE USE

a. Set the HIGH VOLTAGE switch to **STANDBY-RESET**.

b. Set the POWER switch to **ON**. The POWER lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the **STANDBY-RESET** lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the load to the power supply. Be sure the connection is firm.

**WARNING**

This instrument can produce lethal voltage. Always set the HIGH VOLTAGE switch to **STANDBY-RESET** and wait until the output decays to zero before connecting or disconnecting the load.

e. Set the OUTPUT VOLTAGE controls to the desired output. Check the external circuit for conflicts in grounding before applying power to the load.

**CAUTION**

The sampling string resistors in the 410B are subject to damage if the output voltage is reduced too rapidly. Pause approximately 1/2 second in each switch position when reducing the setting of the first decade switch (1000 volt increments).

f. After the **STANDBY-RESET** lamp illuminates, set the HIGH VOLTAGE switch to **ON**. The **STANDBY-RESET** lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The meter will indicate the approximate output voltage.

**NOTE**

If the overcurrent trip level has been reduced to less than 8 ma, it may be necessary to set the HIGH VOLTAGE switch to **ON** with a reduced output voltage to prevent actuating the overcurrent trip. In this case, step e., above, would follow step f. Figure 2-2 is a graph of the approximate maximum output voltage increment vs. the overcurrent trip setting. For example, if the overcurrent trip point has been reduced to 6 ma, the output voltage must be set to less than 3000 volts (approximately) to prevent actuating the overcurrent trip when the HIGH VOLTAGE switch is set to **ON**. Figure 2-2 is typical, and is intended to show only the general characteristic.

g. To remove the high voltage from the output connectors, set the HIGH VOLTAGE switch to **STANDBY-RESET**.

2-8. USE AS A CALIBRATOR

2-9. The 410B may be used for direct calibration of dc instruments to an accuracy of better than 0.25% or 250 millivolts at any voltage up to 10,000 volts. The

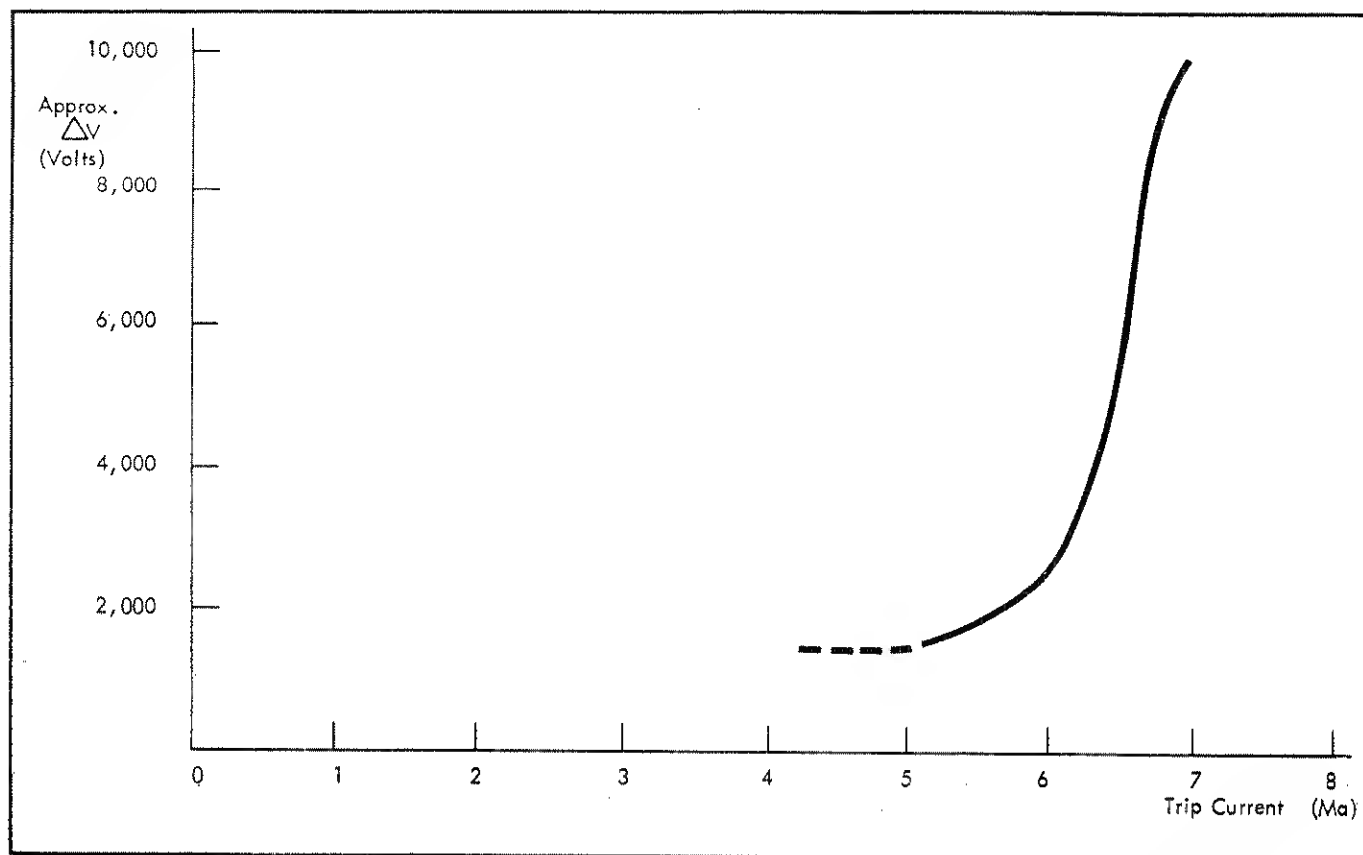


Figure 2-2. TYPICAL OUTPUT VOLTAGE INCREMENT VS. OVERCURRENT TRIP SETTING

four decade switches provide discrete steps with a resolution of one volt per step. The fifth dial provides a vernier with resolution of better than 5 millivolts for calibration between the cardinal points. When used with a Fluke differential voltmeter and voltage divider, the 410B is capable of calibrating dc instruments from 0 to 10,000 volts with an accuracy of 0.02% to 0.06%, depending upon the accuracy of the voltage divider and differential voltmeter used.

#### 2-10. DIRECT CALIBRATION

a. Allow the power supply sufficient time to warm up to stable operating temperature, usually not less than one half hour. If possible, set the OUTPUT VOLTAGE dials for the maximum required output during warmup in order to stabilize the operating temperature of all of the sample-string resistors which will be used during calibration. When used in this manner the power supply will provide an output significantly better in stability and accuracy than is specified.

b. Set the POLARITY switch to the desired polarity.

c. Set the HIGH VOLTAGE switch to STANDBY-RESET.

d. Connect the instrument being calibrated to the OUTPUT connector.

e. Set the OUTPUT VOLTAGE dials to the initial calibration point.

f. Set the HIGH VOLTAGE switch to ON.

g. Successively set the OUTPUT VOLTAGE dials to the desired calibration points.

#### 2-11. PRECISION CALIBRATION

a. Warm up supply as in paragraph 2-10a.

b. Set the POLARITY switch to the desired polarity.

c. Set the HIGH VOLTAGE switch to STANDBY-RESET.

d. Connect the instrument being calibrated to the OUTPUT connector. Also connect a voltage divider, such as a Fluke Model 80B-10 to the OUTPUT connector.

e. Connect a Fluke DC differential voltmeter to the output of the voltage divider. For calibration below 500 volts (1000 volts with the newer Fluke differential voltmeters) the voltage divider may be omitted.

f. Set the differential voltmeter to differentially measure the voltage at the desired calibration point. When the voltage divider is used, consider the division ratio when setting the dials of the voltmeter.

g. Set the HIGH VOLTAGE switch to ON.

h. Null the differential voltmeter by adjusting the power supply OUTPUT VOLTAGE dials. The accuracy of calibration is from 0.02% to 0.06%, depending on the accuracy of the differential voltmeter and voltage divider used.

i. Repeat steps f. and h. for as many calibration points as desired.

#### 2-12. NOTES ON OPERATION

#### 2-13. METER ACCURACY

2-14. The meter in the 410B has a basic accuracy of  $\pm 2\%$ . Since multiplying and shunting resistors are used, the overall accuracy is approximately  $\pm 3\%$  of end scale. However, the accuracy of the supply is  $\pm 0.25\%$  of the output voltage. For example, if a voltage of 5000 volts is selected, the output voltage will be 5000 ( $\pm 12.5$ ) volts ( $\pm 0.25\%$  of 5000 =  $\pm 12.5$ ). However, the panel meter may indicate 5000 ( $\pm 300$ ) volts ( $\pm 3\%$  of 10,000 =  $\pm 300$ ) and still be within specified accuracy. Consequently, the front panel controls should be relied upon to indicate the magnitude of the output voltage.

#### 2-15. OVERLOAD PROTECTION

2-16. The 410B is protected from damage due to overload by an overcurrent trip circuit. This circuit will return the supply to standby operation if the output current exceeds the pre-set level. This level is internally adjustable, and is usually set for 12 milliamperes,

but may be adjusted to lower levels, down to approximately 5 milliamperes. If tripped, the supply may be returned to operation by setting the HIGH VOLTAGE switch to STANDBY-RESET, waiting 30 seconds for the time-delay relay to close, and then setting the HIGH VOLTAGE switch to ON.

#### 2-17. POLARITY SWITCHING

2-18. The output polarity of the 410B may be changed by pulling out the POLARITY switch until it reaches the stop, rotating the switch to the desired polarity, and pushing the switch all the way back to the stop. An interlock (S9) actuated by the switch shaft disables the instrument when the switch is pulled out. In order to return the supply to operation, the HIGH VOLTAGE switch must be set to STANDBY-RESET. After 30 seconds, when the STANDBY-RESET lamp illuminates, set the HIGH VOLTAGE switch to ON.



## 2-19. COAXIAL CABLE ASSEMBLY

2-20. Coaxial cables used to connect the instrument to a load are not provided by John Fluke Mfg. Co., Inc. Procurement of cables and the assembly of mating cable connectors must be carefully undertaken to insure safety of personnel.

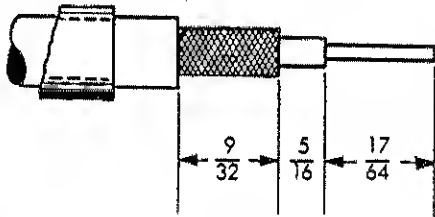
### WARNING!

Extreme care should be exercised when utilizing high voltage conductors and connectors. Improper assembly of cable connectors or careless use of high voltage equipment may expose personnel to voltage of lethal magnitude.

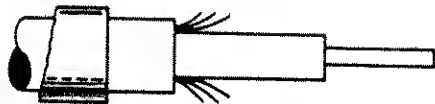
2-21. General instructions are provided herein for the assembly of two types of cable connectors issued as an accessory item with John Fluke instruments. Additional information on the assembly of these connectors, or on other types of connectors considered for use with the instrument, may be obtained from the cable or connector vending agency.

## 2-22. DAGE TYPE 486-1 CONNECTOR ASSEMBLY

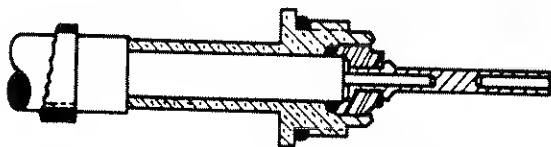
a. Cut cable off square on end. Slide outer sleeve over cable and slide back out of way. Trim cable to dim. shown being careful not to nick center conductor or braid. Tin dip center conductor. Remove all excess solder.



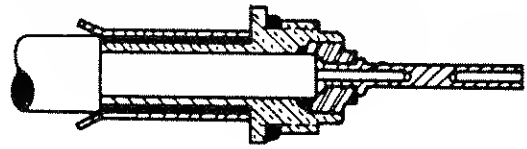
b. Rotate dielectric to slightly flare braid.



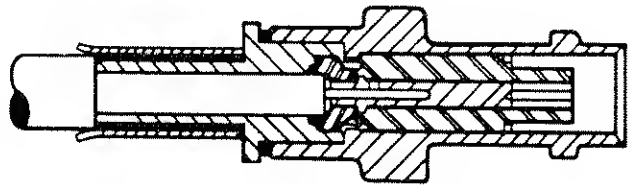
c. Push cable into nut sub-assembly until the center conductor is visible thru hole in contact. Soft solder center conductor thru hole in contact. Remove excess solder. Fold braid down over back end tube of nut. Trim excess braid if necessary.



d. Slide outer sleeves over braid until it is flush against back of nut. Crimp as close to nut as possible using proper crimping tool.



e. Insert finished cable assy. into body either jack or plug and tighten by rotating body. Do not rotate nut sub-assembly.

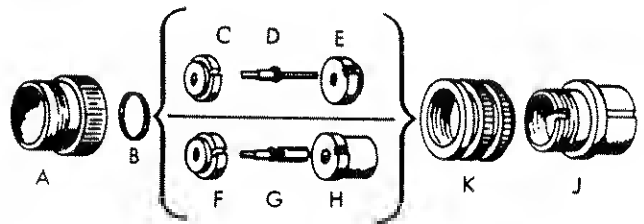


## 2-23. AMPHENOL MS 3106A CONNECTOR ASSEMBLY

a. Strip cable jacket, braid, and dielectric to dimensions shown. All cuts are to be sharp and square. Do not nick braid, dielectric, and center conductor. Tinning of center conductor is not necessary if contact is to be crimped. For solder method, tin center conductor avoiding excessive heat..



b. Disassemble connector by removing the back shell and retainer ring.



### WITH PIN INSERT (Male)

- A Back Shell
- B Retainer Ring
- C Pin Rear Insert
- D Pin Contact
- E Pin Front Insert
- J Front Shell
- K Coupling Ring

### WITH SOCKET INSERT (Female)

- A Back Shell
- B Retainer Ring
- F Socket Rear Insert
- G Socket Contact
- H Socket Front Insert
- J Front Shell
- K Coupling Ring

c. Insert cable thru clamp MS 3057A and rear components of connector. Place the cable center conductor into the socket contact.

d. Soft solder contact to cable center conductor. Do not get any solder on outside surfaces of contact. Avoid excessive heat to prevent swelling or dielectric.

Contact must butt against cable dielectric



e. Provide a connection from the cable shield to the securing bolt of the cable clamp. The connecting copper wire should be approximately 5 inches long and size 14 or larger in diameter. A terminal lug should be used to connect the wire to the clamp. The wire should be carefully soldered to the shield, taking care not to damage the insulation of the cable. Loose ends of the shield should be clipped off to prevent shorting the center conductor or contact to the shield.

f. Assemble the cable connector by placing the contact into the socket front insert, then coupling the back shell to the front shell in the reverse of the disassembly procedure.

## SECTION III

# THEORY OF OPERATION

### 3-1. INTRODUCTION

3-2. This section of the manual describes the operation of the Model 410B. Reference is made to the functional schematic following Section V. This schematic is intended to aid in understanding the theory of operation, and in troubleshooting. A block diagram of the 410B is given in Figure 3-1. Operation of the 410B is discussed in the following paragraphs.

### 3-3. OVERALL OPERATION

3-4. The output voltage is controlled by the series passing tube V202, which is controlled by the feedback amplifier consisting of Q208 through Q214. Transistors Q213 and Q214 are connected as a differential amplifier, in which the output is proportional to the difference between the two inputs. The input of Q214 is connected to the summation point, which is the junction of the reference resistor R106, and the voltage control resistors R107 through R140. The feedback amplifier controls the output voltage so that the summation point is essentially at the same potential as the positive output bus. Any voltage difference between these two points is

amplified by the differential amplifier, and further amplified by Q212 through Q208, and applied to the grid of the series passing tube V202. The passing tube then increases or decreases its conductance until the voltage at the summation point is equal to the voltage of the positive bus. Tube V201 is a highly stable voltage reference which maintains a constant voltage of approximately 83 volts. Since the summation point is always held near zero volts, a constant current of 2 milliamperes flows through reference resistors R104 through R106, and also through voltage control resistors R107 through R140. The output voltage is equal to the IR drop across the voltage control resistors, and may thus be precisely controlled by varying the resistance of the voltage control string.

### 3-5. CIRCUIT DESCRIPTIONS

### 3-6. CONTROL RELAYS

3-7. A full-wave rectifier is formed by CR301 through CR304, which furnishes dc voltage to the control relays K301 and K302. Approximately 30 seconds after power is applied to the instrument, time-delay relay K301

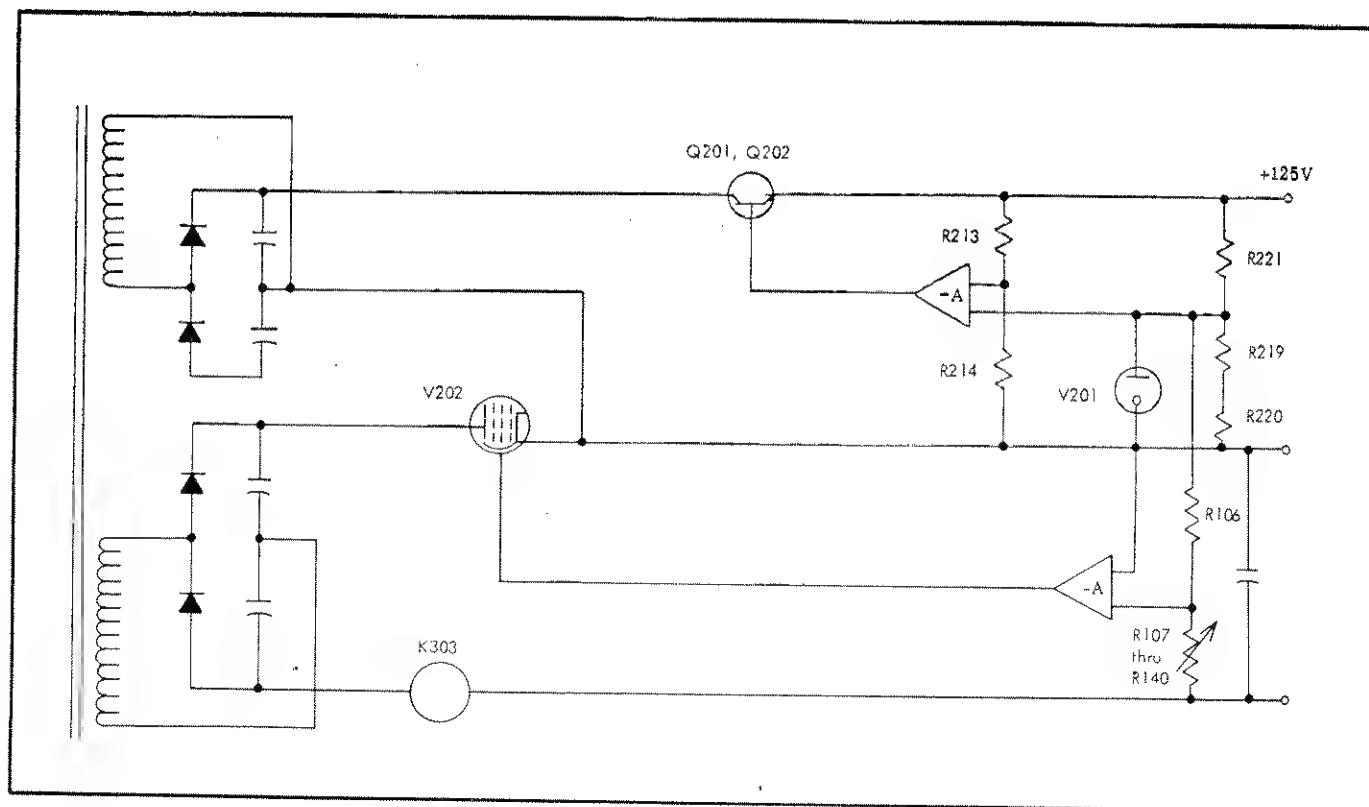


Figure 3-1. MODEL 410B DC POWER SUPPLY - BLOCK DIAGRAM

closes if S2 is set to the STANDBY-RESET position. This energizes K302, which opens K302A, removing K301 from the circuit, and closes K302B and K302C. When switch S2 is set to the HIGH VOLTAGE ON position after K302C is closed, the primary of transformer T2 is energized and transformer voltage is applied to CR401 and CR402.

### 3-8. OVERCURRENT PROTECTION

3-9. Relay K303 provides overcurrent protection. If the output current exceeds approximately 12 milliamperes, K303 is actuated, which closes K303A. This de-energizes K302, which closes K302A, and opens K302B and K302C, extinguishing the HIGH VOLTAGE ON lamp. The primary circuit of T2 is thus opened by K302C, and high voltage is removed from the output terminals. Before high voltage can be reapplied to the output terminals, switch S2 must be set to the STANDBY-RESET position. After the time-delay cycle is complete, voltage will be available at the output connector when the HIGH VOLTAGE switch, S2, is set to ON.

### 3-10. MAIN OUTPUT VOLTAGE

3-11. The main output voltage is developed by CR401, CR402, C3, C4, and R402 through R411. This is a full-wave, voltage-doubler circuit, which applies rectified, filtered, dc voltage to the plate of V202. The taps on the primary of T2 provide approximate control of the unregulated dc voltage, which minimizes power dissipation in V202 at low output voltage.

### 3-12. FEEDBACK AMPLIFIER

3-13. The feedback amplifier consists of essentially five stages composed of seven silicon transistors. Transistors Q213 and Q214 are connected as a differential amplifier. The output is taken from the collector load of Q214 and is applied to the common-emitter amplifier Q212. Output from the collector of Q212 is ac coupled back to the base of Q213 as negative feedback for loop stabilization. The output of Q212 is applied to the input of the compound-connected, emitter-follower pair of Q210 and Q211. This stage provides current gain and impedance matching between the high collector impedance of Q212 and the low emitter impedance of Q209. Transistors Q209 and Q208 are common base stages which provide the voltage gain and large voltage swing required by the grid of V202. C215 and R230 in the emitter of Q209 form a lead network for loop compensation.

### 3-14. AUXILIARY SUPPLIES

3-15. AC voltage for both the positive and negative auxiliary supplies is obtained from one transformer winding. One terminal of this winding is connected to the positive output of the 410B, which is the zero volt reference. The other terminal of the winding is con-

nected to the junction of two half-wave rectifiers and filters. The positive auxiliary voltage is obtained from CR201, CR202, and C202. Auxiliary voltages of +95 volts, +20 volts, and +10 volts are obtained from CR205, CR206, and CR207, respectively, which are connected across the positive auxiliary voltage. The negative auxiliary voltage is obtained from CR203, CR204, and C203. An auxiliary voltage of -110 volts is obtained from CR208. This arrangement of the +95V, +20V, +10V, and -110V auxiliary supplies provides shunt regulation of these supplies.

### 3-16. REFERENCE VOLTAGE

3-17. Reference voltage for the instrument is obtained from V201, a gas-filled reference tube. Resistor R219 has a temperature coefficient of  $+0.45\%/^{\circ}\text{C}$ , which provides temperature compensation for V201. Transistors Q205 and Q206 are used as a differential amplifier. Transistor Q203 is operated as an emitter-follower voltage regulator, which provides 100 volts for the collector of Q205 and the emitter of Q204. The base of Q205 samples the output voltage of the +125 volt auxiliary supply, through the voltage divider R213 and R214. The output from Q206 represents the amplified difference between the reference voltage and the voltage at the base of Q205. Transistor Q204 provides further amplification of this voltage difference for application to series regulators Q202 and Q201. Neon lamps DS201 and DS202 are safety devices to prevent possible burn-out of Q201 and Q202 if the output of the instrument becomes short-circuited.

### 3-18. ACCURACY

3-19. The main sampling string resistors in the 410B are accurate to within  $\pm 0.1\%$ . However, the accuracy of the 410B is specified as  $\pm 0.25\%$ , because the calibration accuracy also depends upon the stability of the reference voltage. The voltage of reference tube V201 (83A1) changes slightly due to aging. The accuracy of the supply will remain within  $\pm 0.25\%$  for at least 30 days. The calibration accuracy may be maintained at better than  $0.25\%$  if the instrument is recalibrated more often than the usual calibration period of 30 days.

3-20. All calibrated power supplies have an accuracy limit (floor) as the output voltage approaches zero. This floor is caused by zero shift in the error amplifier, contact resistance in the sampling string circuit, and the accuracy of the sampling string resistors used for the least significant digits. The accuracy floor may be reduced by using more expensive components and additional circuitry. However, this results in greater initial cost and longer calibration time. Thus, very low accuracy floors are usually found only in precision calibrators. The 410B has an accuracy of  $\pm 0.25\%$  or 250 millivolts, whichever is greater, when the first four voltage controls are used. Thus, the  $\pm 0.25\%$  accuracy applies from 10,000 volts to 100 volts.

## SECTION IV

# MAINTENANCE

### 4-1. INTRODUCTION

4-2. Maintenance of the Model 410B DC Power Supply should consist primarily of occasional cleaning, tube replacement, and calibration. Preventive maintenance is discussed in paragraph 4-3. A discussion of troubleshooting and a troubleshooting chart are presented in paragraph 4-6. Calibration procedures and the equipment necessary are presented in paragraph 4-14.

#### WARNING

Caution should be exercised when servicing this power supply. The metal shell of some of the electrolytic capacitors may be as much as 10, 100 volts above chassis ground. Capacitors C5 and C219 are high-quality, oil-filled units capable of retaining a charge for several days. Before servicing or removing tubes, all capacitors and plate caps should be shorted to the chassis. It is recommended that the shorting wire remain connected to C5 and C219 during servicing to prevent build-up of capacitor voltage due to dielectric absorption.

### 4-3. PREVENTIVE MAINTENANCE

4-4. Periodic cleaning of the Model 410B is desirable because of the high voltage present. Any contamination, particularly on the high voltage capacitors, may cause corona discharge, which will appear as noise in the output voltage. Components may be cleaned with Freon, or with a lint-free rag saturated with denatured alcohol. Ceramic switches may be cleaned with denatured alcohol or tetrachloroethane. After cleaning, the ceramic surface should be coated with a 10% solution of Dow Corning silicon fluid (200 viscosity grade). Denatured alcohol or tetrachloroethane may be used as a thinner for the silicon fluid.

4-5. Printed circuit boards in the 410B are coated with a polyurethane compound to prevent moisture absorption. If components are replaced, it will be necessary to recoat the circuit board in the immediate area of the part replaced. Aerosol containers of Epocast, available from Furane Plastics, Inc., Los Angeles, California, provide a convenient way of recoating the circuit board area. The recoated circuit board does not require baking.

### 4-6. TROUBLESHOOTING

4-7. It is recommended that all checks be made with the POLARITY switch turned to negative output polarity, and when possible, the output voltage set to 500 volts. Most voltages are referred to the positive bus, and when

the output polarity is negative, the positive bus is connected to the earth grounded chassis. This affords some protection to the person performing the tests.

4-8. The power supply should be allowed to warm-up before the following accuracy checks. Usually, one-half hour of operation is adequate. Figure 4-1 is a list of various failures and probable causes. Reference to Figure 4-1 will occasionally indicate the cause of a failure. Components may be located by referring to Section V. A list of equipment required is given in Figure 4-2.

### 4-9. AUXILIARY VOLTAGES

- a. Connect the 881A common lead to the 410B chassis ground (shell of the OUTPUT connector).
- b. Set the POLARITY switch to negative.
- c. Set the POWER switch to ON.
- d. Set the OUTPUT VOLTAGE controls to zero.
- e. Set the HIGH VOLTAGE switch to ON.
- f. Connect the 881A positive lead to the junction of CR206 and CR207.
- g. The 881A should indicate +10 ( $\pm 1$ ) vdc.
- h. Connect the 881A positive lead to the junction of CR205 and CR206.
- i. The 881A should indicate +20 ( $\pm 2$ ) vdc.
- j. Connect the 881A positive lead to the junction of CR205 and R203.
- k. The 881A should indicate +95 ( $\pm 9.5$ ) vdc.
- l. Connect the 881A positive lead to the junction of CR208 and R205.
- m. The 881A should indicate -110 ( $\pm 11$ ) vdc.
- n. Connect the 881A positive lead to the positive end of C211. Also connect the 910A RMS Voltmeter across the same points as the 881A.
- o. The 881A should indicate 125 ( $\pm 2.25$ ) vdc. The 910A should indicate less than 0.005 volts rms ripple.

### 4-10. LINE REGULATION AND RIPPLE

- a. Connect the variable transformer between the 410B and the line. Set the transformer to 115 volts output.

#### WARNING

A good power line ground must be provided when the variable transformer is used.

- b. Connect the 910A and the 881A across the OUTPUT connector. Also connect the oscilloscope across the OUTPUT connector.
- c. Set the POWER switch to ON.
- d. Set the HIGH VOLTAGE switch to ON.
- e. Set the OUTPUT VOLTAGE controls to 500 volts, and record the voltage indicated by the 881A.
- f. Increase the variable transformer output to 127 vac,

| SYMPTOM  | PROBABLE CAUSE  | REMEDY  |
|--|---|---|
| No output  | Blown fuse<br>Open heater of V202<br>Open R104; Shorted C219  | Check fuse F1, and replace if necessary.<br>Determine if tube will warm-up; if not replace.<br>Check and replace if necessary.  |
| Constant percentage error in output voltage                                    | Out of calibration<br>Defective R106  | Recalibrate per paragraph 4-14.<br>Check and replace if necessary.  |
| Percentage error over part of range<br>or<br>Output erratic over part of range | Defective wirewound resistor in the sampling string.<br>(R107 thru R140)  | Set the output voltage to a maximum and decrease one switch position at a time until the error disappears. The defective resistor will be found at the last switch position in which the error was noted. |
| Output erratic over entire range   | Defective V202<br>Defective output voltage switch, or dirty switch printed circuit board.<br>Defective R104 or R106 | Test and replace if necessary.<br>Replace switch, clean printed circuit board.<br>Check and replace if necessary.   |
| Output rises to over 10KV and follows line voltage variations                  | Defective V202, or Q208 thru Q214<br><br>Open sampling resistor or switch   | Test and replace if necessary.<br><br>Test R107 thru R140, and S3 thru S6, and replace if necessary.  |
| Poor load regulation   | Defective Q208 thru Q214  | Check and replace if necessary.   |
| Output voltage suddenly rises above preset value                               | Internal arcing in V202   | Check and replace if necessary.   |
| Noise in output  | Dirty high-voltage switches, capacitors, or printed circuit boards.   | Clean per paragraph 4-4.  |
| Excessive drift  | Defective V201, Q213, or Q214   | Check by replacement.   |
| Excessive ripple   | Excessive ripple in +125V auxiliary supply<br><br>Defective C219, C5, Q213, or Q214                                 | If auxiliary supply ripple exceeds approximately 5 mv, replace defective component.<br><br>Check and replace if necessary.  |
| Loss of control  | Open R243   | Check and replace if necessary.   |

Figure 4-1. TROUBLESHOOTING

| EQUIPMENT  | SPECIFICATIONS REQUIRED  |
|--|--|
| Variable transformer   | 3 ampere capacity, 100 volts to 130 volts output.  |
| RMS Voltmeter, Fluke Model 910A, or equivalent                             | RMS measurement of non-sinusoidal waves.   |
| DC Differential Voltmeter, Fluke Model 881A, or equivalent                 | Voltmeter/Voltage Divider must be capable of measuring 0 to 10,000 vdc with a minimum accuracy of 0.05% + 50 microvolts. Voltmeter must have a 1 millivolt null detector for use with the 80E. |
| Voltage Divider, Fluke Model 80E-10, or equivalent                         |  |
| Oscilloscope, Tektronix Model 541, with Type L plug-in unit, or equivalent | Minimum sensitivity of 5 mv/cm.<br>10 MHz bandwidth.   |
| Blocking capacitor   | 0.05 microfarads, 10,000 vdc rating.   |
| Load resistors   | 50K $\pm 5\%$ , 5W<br>1K $\pm 5\%$ , 2W  |
| Insulated screwdriver  | Must have solid insulated shaft capable of withstanding 10,000 vdc.  |

Figure 4-2. EQUIPMENT REQUIRED FOR TROUBLESHOOTING AND CALIBRATION

while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should be less than 1 millivolt rms, and 5 millivolts peak-to-peak, respectively. The voltage change indicated by the 881A should be less than 5 millivolts.

g. Decrease the transformer output from 115 vac to 103 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should be less than 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltage change indicated by the 881A should be less than 5 millivolts from step e.

h. If desired, repeat steps e. through g. with the POLARITY switch in the opposite polarity.

i. Set the variable transformer to 115 vac output, and set the HIGH VOLTAGE switch to STANDBY-RESET.

j. Disconnect the 881A and the 910A.

k. Connect the 80E-10 Voltage Divider to the output of the 410B, and connect the 881A to the output of the voltage divider.

l. Connect the 10KV blocking capacitor in series with the 910A input, and connect the series combination across the 410B OUTPUT connector.

m. Set the HIGH VOLTAGE switch to ON.

n. Set the OUTPUT VOLTAGE controls to 10,000 volts, and record the voltage measured by the voltmeter/voltage divider combination.

o. Increase the variable transformer output to 127 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should not exceed 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltmeter/voltage divider should indicate less than 0.100 volts change in the 410B output voltage from the value measured in step n.

p. Decrease the transformer output from 115 vac to

103 vac, while observing the 910A. Ripple indicated by the 910A and by the oscilloscope should not exceed 1 millivolt rms and 5 millivolts peak-to-peak, respectively. The voltmeter/voltage divider should indicate less than 0.100 volts change in the 410B output voltage from the value measured in step n.

q. If desired, repeat steps n. through p. with the POLARITY switch in the opposite polarity.

#### 4-11. LOAD REGULATION

a. Connect the variable transformer between the 410B and the line. Set the transformer to 103 vac output.

b. Connect the 881A across the OUTPUT connector.

c. Set the POWER switch to ON.

d. Set the HIGH VOLTAGE switch to ON.

e. Set the OUTPUT VOLTAGE controls to 500 volts.

f. Record the voltage indicated by the 881A.

g. Carefully connect the 50K load resistor across the OUTPUT connector. The load current should be 0.010 ampere.

h. The 881A should indicate less than 0.005 volts change from the voltage measured in step f.

#### 4-12. STABILITY

a. Connect the 80E-10 to the output of the 410B, and connect the 881A to the output of the voltage divider.

b. Set the POWER switch to ON.

c. Set the HIGH VOLTAGE switch to ON.

d. Set the OUTPUT VOLTAGE controls to 10,000 volts.

e. After a minimum operating time of 30 minutes, record the voltage indicated by the voltmeter/voltage divider.

f. After an additional 60 minutes of operation, the voltage change indicated by the voltmeter/voltage divider should be less than 0.5 volt (0.0005 volt indicated by the 10V tap).

#### 4-13. OUTPUT AT ZERO VOLTS

- Connect the voltmeter to the OUTPUT connector.
- Set the POWER switch to ON.
- Set the OUTPUT VOLTAGE controls to zero.
- Set the HIGH VOLTAGE switch to ON.
- The 881A should indicate less than 0.030 volts in both output polarities. If not, exchange Q213 and/or Q214 with another transistor of the same type used elsewhere in the instrument, so that the beta of the two transistors is more nearly equal.

#### 4-14. CALIBRATION

4-15. The Model 410B may be calibrated as often as necessary. However, it is recommended that the reference voltage be checked every 30 days, and the overcurrent limit be checked every six months. As reference tube V201 (83A1) ages, the reference voltage changes slightly. It has been found that some reference tubes are more stable than others. However, most reference tubes will change by less than 0.1% for every 100 hours of operation after the first hundred hours. If the output voltage is recorded before the reference current is adjusted, a more realistic calibration period can be determined. The equipment required for calibration is given in Figure 4-2.

#### 4-16. REFERENCE CURRENT ADJUSTMENT

- Connect the 80E-10 Voltage Divider to the output of the 410B, and connect the voltmeter to the output of the voltage divider.
- Set the OUTPUT VOLTAGE controls to 9,900 volts, using only the first two dials.
- Set the POLARITY switch to negative.
- Set the POWER switch to ON.
- Set the HIGH VOLTAGE switch to ON.
- Set the differential voltmeter to differentially measure 9,900 volts, considering the voltage divider ratio. For example, using the 80E-10 Voltage Divider, set the differential voltmeter to measure 9.9 volts.

#### WARNING

Use an insulated screwdriver to adjust R104. The case of this resistor is 85 volts above

chassis ground for negative output polarity, and may be as much as 10,085 volts above ground for positive output polarity.

g. After a minimum operating time of 30 minutes, adjust R104 for a null on the differential voltmeter. Within 24 volts of 9,900 volts is sufficient (24 millivolts with the 80E-10). This control may be adjusted through the access hole on the right side panel near the front.

#### 4-17. OVERCURRENT TRIP ADJUSTMENT

- Connect a 1K  $\pm 5\%$ , 2W resistor to the OUTPUT connector.
- Set the OUTPUT VOLTAGE controls to zero.
- Set the POLARITY switch to negative.
- Set the POWER switch to ON.
- Set the HIGH VOLTAGE switch to ON.
- Set the 410B for maximum current trip by turning R151 completely clockwise. This control may be adjusted through the access hole on the left side of the instrument.
- Set the OUTPUT VOLTAGE controls to that output voltage which will deliver 12 milliamperes to the load resistor. For example, 12 volts will deliver approximately 12 milliamperes to a 1K resistor.

#### NOTE

If it is desired to set the overcurrent trip to some value other than 12 milliamperes, then the output voltage in step g. should be chosen to provide the desired trip current.

h. Slowly turn R151 counter-clockwise until the overcurrent trip removes power from the high voltage transformer.

#### 4-18. METER CALIBRATION

4-19. The panel meter is adjusted at the factory, and will not usually require attention. If adjustment is necessary, proceed as follows:

- Set the POWER switch to ON.
- Set the HIGH VOLTAGE switch to ON.
- Set the OUTPUT VOLTAGE controls to 10,000 volts.
- Adjust R150 so that meter deflection corresponds to 10KV. This resistor may be adjusted through the access hole on the bottom of the instrument.



## SECTION V

### LIST OF REPLACEABLE PARTS

#### 5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

- a. The REFERENCE DESIGNATION column indicates the reference designation used on the schematic diagram.
- b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.
- c. Entries in the FLUKE STOCK NUMBER column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.
- d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.
- e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.
- f. The number in the TOTAL QTY column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.
- g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support

approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate serial number. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

#### 5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

- a. Reference designation, description, and Fluke stock number.
- b. Instrument model and serial number.
- c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

# 5-7. ABBREVIATIONS

|            |                                |
|------------|--------------------------------|
| ac         | alternating current            |
| Al         | aluminum                       |
| assy       | assembly                       |
| cap        | capacitor                      |
| car film   | carbon film                    |
| cer        | ceramic                        |
| comp       | composition                    |
| conn       | connector                      |
| cps        | cycles per second              |
| db         | decibel                        |
| dc         | direct current                 |
| dpdt       | double pole double throw       |
| dpst       | double pole single throw       |
| elect      | electrolytic                   |
| fxd        | fixed                          |
| Ge         | germanium                      |
| gmV        | guaranteed minimum value       |
| Hz         | hertz (cycles per second)      |
| K          | kilohm                         |
| kc or Kc   | kilocycle                      |
| kHz or KHz | kilohertz (kilocycles per/sec) |
| kv         | kilovolt                       |
| kva        | kilovolt-ampere                |
| ma         | milliampere                    |
| Mc or MC   | megacycle                      |
| MHz        | megahertz (megacycles per/sec) |
| meg or M   | megohm                         |
| met film   | metal film                     |
| mfg        | manufacturer                   |
| mv         | millivolt                      |
| mw         | milliwatt                      |
| na         | nanoampere                     |
| pf         | picofarad                      |
| piv        | peak inverse voltage           |
| plstc      | plastic                        |
| pp         | peak-to-peak                   |
| ppm        | parts per million              |
| rect       | rectifier                      |
| res        | resistor                       |
| rms        | root-mean-square               |
| sb         | slow-blow                      |
| Si         | silicon                        |
| S/N        | serial number                  |
| sw         | switch                         |
| spdt       | single pole double throw       |
| spst       | single pole single throw       |
| Ta         | tantalum                       |
| tc         | temperature coefficient        |
| tstr       | transistor                     |
| ua         | microampere                    |
| uf         | microfarad                     |
| uv         | microvolt                      |
| va         | volt ampere                    |
| vac        | alternating current volts      |
| var        | variable                       |
| vdc        | direct current volts           |
| w          | watt                           |
| wvdc       | direct current working volts   |
| ww         | wirewound                      |

# 5-8. PREFIX SYMBOLS

|        |       |                   |
|--------|-------|-------------------|
| T      | tera  | 10 <sup>12</sup>  |
| G      | giga  | 10 <sup>9</sup>   |
| M      | mega  | 10 <sup>6</sup>   |
| K or k | kilo  | 10 <sup>3</sup>   |
| h      | hecto | 10 <sup>2</sup>   |
| da     | deka  | 10                |
| d      | deci  | 10 <sup>-1</sup>  |
| c      | centi | 10 <sup>-2</sup>  |
| m      | milli | 10 <sup>-3</sup>  |
| u      | micro | 10 <sup>-6</sup>  |
| n      | nano  | 10 <sup>-9</sup>  |
| p      | pico  | 10 <sup>-12</sup> |
| f      | femto | 10 <sup>-15</sup> |
| a      | atto  | 10 <sup>-18</sup> |

# 5-9. QUANTITY SYMBOLS

|          |        |
|----------|--------|
| a or amp | ampere |
| f        | farad  |
| h        | henry  |
| hr       | hour   |
| Ω        | ohm    |
| sec      | second |
| v or V   | volt   |
| w or W   | watt   |

# 5-10. SPECIAL NOTES AND SYMBOLS

|                 |  |
|-----------------|--|
| ~ 000           | Approximate serial number  |
| Use 0000-000000 | Part number indicated should be used if replacement is required. |

| REF<br>DESIG.  | DESCRIPTION   | FLUKE<br>STOCK NO.        | MFR.  | MFR.<br>PART NO.     | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|----------------|---|---------------------------|-------|----------------------|--------------|--------------|-------------|
|                | Final Assembly (see Figure 5-1)                       | 410B                      | 89536 |                      |              |              |             |
|                | Front Panel Assembly<br>(see Figure 5-2)              | 3158-175729<br>(410B-406) | 89536 | 3158-175729          | 1            |              |             |
|                | Switch PCB Assembly<br>(see Figure 5-3)               | 1702-175679<br>(410B-401) | 89536 | 1702-175679          | 1            |              |             |
|                | Amplifier PCB Assembly<br>(see Figure 5-4)            | 1702-175687<br>(410B-402) | 89536 | 1702-175687          | 1            |              |             |
|                | Time Delay PCB Assembly<br>(see Figure 5-5)           | 1702-175695<br>(410B-403) | 89536 | 1702-175695          | 1            |              |             |
|                | Rectifier PCB Assembly<br>(see Figure 5-6)            | 1702-175703<br>(410B-404) | 89536 | 1702-175703          | 1            |              |             |
| C1, C2         | Cap, cer, 0.01 uf -20/+80%, 500V<br>(not illustrated) | 1501-105668               | 56289 | 29C9B5               | 2            |              |             |
| C3, C4         | Cap, oil, .25/.25 uf $\pm 20\%$ , 7.5KV               | 1505-163766               | 99120 | LK-75-504C           | 1            |              |             |
| C5             | Cap, oil, 0.25 uf $\pm 20\%$ , 10KV                   | 1505-163758               | 99120 | LK-100-254N          | 1            |              |             |
| C219           | Cap, oil, 0.05 uf $\pm 10\%$ , 10KV                   | 1505-161158               | 01884 | SMLE503-10M          | 1            |              |             |
| J2             | Connector, H. V.                                      | 2104-100172               | 02660 | MS3102A-18-16S<br>-C | 2            |              |             |
| K301           | Relay, time delay 115V, 30 sec.                       | 4502-105288               | 70563 | 115N030T             | 1            | 1            |             |
| P1             | Line cord set, 3 wire                                 | 6005-102822               | 70903 | PVC-PH-70            | 1            |              |             |
| R1             | Res, comp, 470 $\Omega$ $\pm 10\%$ , 1W               | 4704-109710               | 01121 | GB4711               | 1            |              |             |
| S3A            | Switch section, rot., 11 positions, 1 pole            | 5107-176149               | 71590 | PS-284               | 1            |              |             |
| S3B            | Switch rotor assembly                                 | 5108-175612               | 89536 | 5108-175612          | 1            |              |             |
| S7             | Switch, rotary  | 5110-175711               | 89536 | 5110-175711          | 1            |              |             |
| S8, S9,<br>S10 | Switch, interlock<br>(S9 and S10 not illustrated)     | 5104-115196               | 01963 | E13-00A              | 3            |              |             |
| T1             | Transformer, aux.                                     | 5600-176032               | 89536 | 5600-176032          | 1            |              |             |
| T2             | Transformer, H. V.                                    | 5600-176024               | 89536 | 5600-176024          | 1            |              |             |
| V202           | Electron tube, type 4-65A                             | 5701-192351               | 89536 | 5701-192351          | 1            | 1            |             |
|                | Meter cover   | 3155-169813               | 97945 | 1704-462-Y           | 1            |              |             |
|                | Feet, rubber (not illustrated)                        | 2819-103309               | 83478 | 9102-W               | 4            |              |             |
|                | Knob assembly, pol. sw.                               | 2405-175620               | 89536 | 2405-175620          | 1            |              |             |
|                | Switch detent, 10 position, short                     | 5108-155945               | 76854 | 239914-H             | 3            |              |             |
|                | Switch detent, 10 position, long                      | 5108-167833               | 76854 | 246305-H             | 1            |              |             |

| REF<br>DESIG. | DESCRIPTION             | FLUKE<br>STOCK NO. | MFR.  | MFR.<br>PART NO. | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|---------------|-------------------------|--------------------|-------|------------------|--------------|--------------|-------------|
|               | Mating connector, H. V. | 2104-100156        | 02660 | MS3106A-18-16P   | 1            |              |             |
|               | Knob, 1-1/2"            | 2405-170035        | 89536 | 2405-170035      | 5            |              |             |
|               | Cable clamp             | 2804-100149        | 02660 | AN3057 .0        | 1            |              |             |
|               | Cap, H.V. connector     | 3155-172122        | 89536 | 3155-172122      | 2            |              |             |

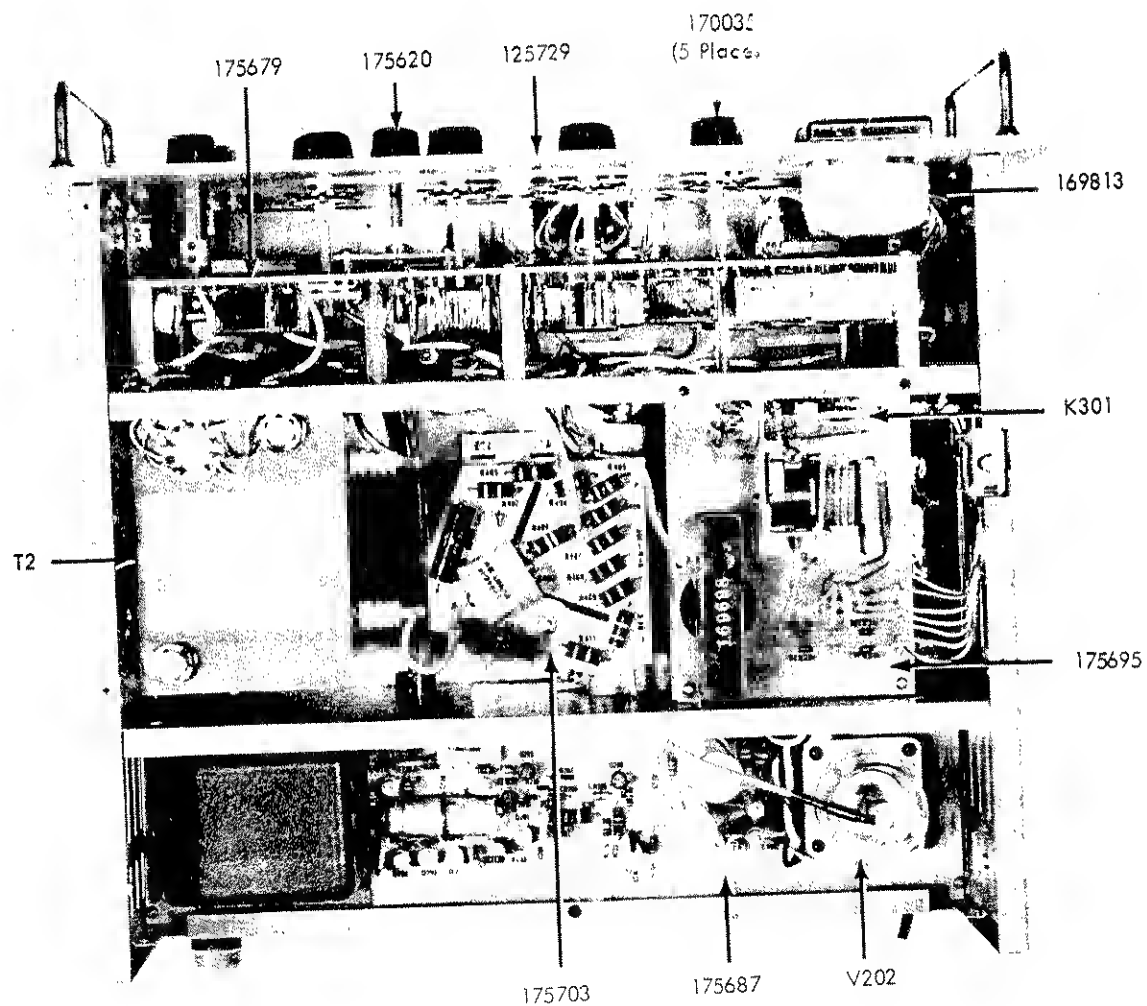


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 2)

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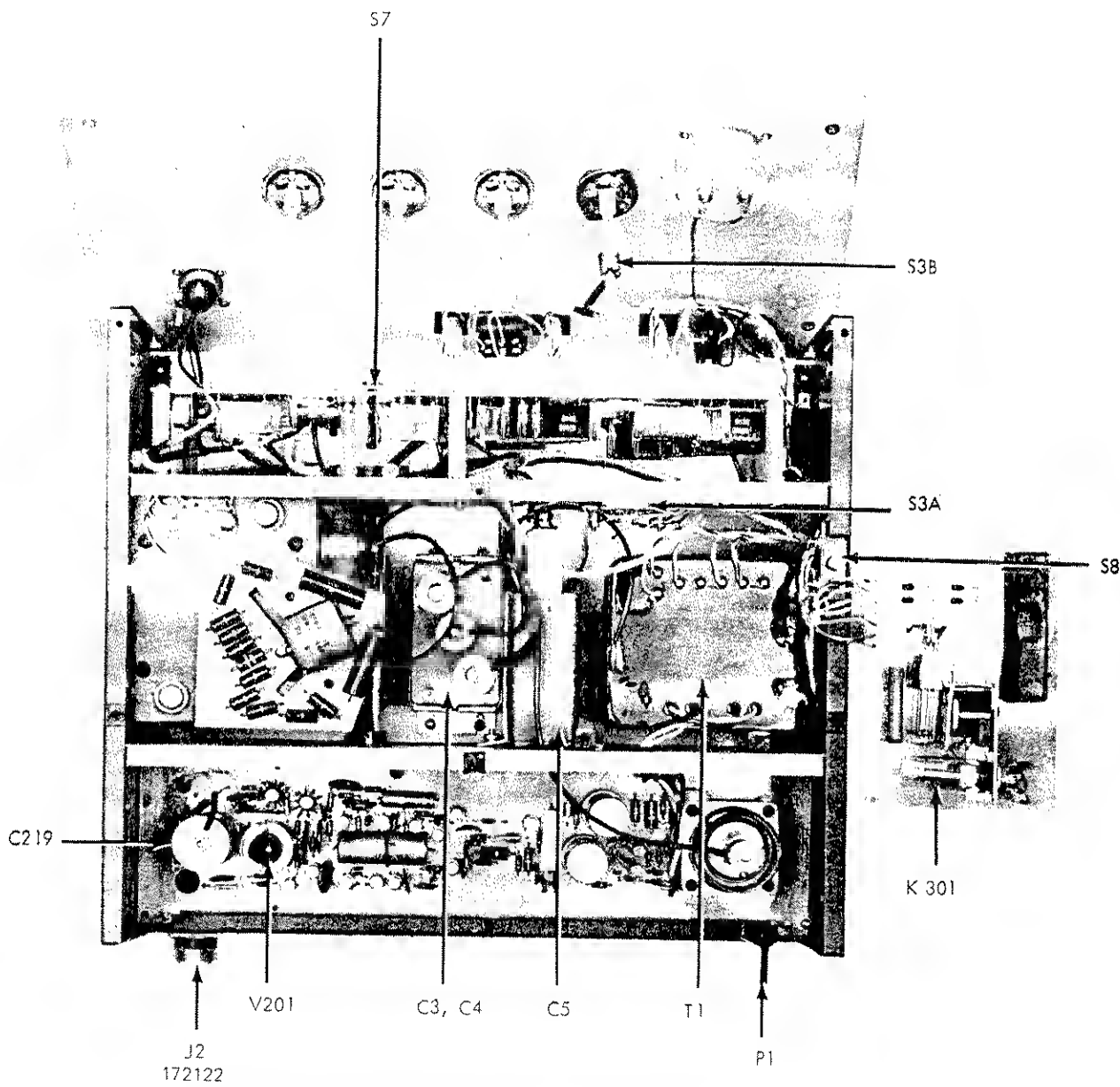


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 2)

| REF<br>DESIG. | DESCRIPTION                     | FLUKE<br>STOCK NO.        | MFR.  | MFR.<br>PART NO.     | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|---------------|---------------------------------|---------------------------|-------|----------------------|--------------|--------------|-------------|
|               | Front Panel Assembly            | 3158-175729<br>(410B-406) | 89536 | 3158-175729          | REF          |              |             |
| DS1           | Lamp, red lens                  | 3903-100206               | 91802 | 1040A1               | 2            |              |             |
| DS2           | Lamp, white lens                | 3903-100214               | 91802 | 1040A4               | 1            |              |             |
| DS3           | Lamp, red lens                  | 3903-100206               | 91802 | 1040A1               | REF          |              |             |
| F1            | Fuse, 3A, sb (not illustrated)  | 5101-109280               | 03614 | Type MDA             | 1            | 3            |             |
| J1            | Connector, H. V.                | 2104-100172               | 02660 | MS3102A-18-<br>16S-C | REF          |              |             |
| M1            | Meter, 50Ω, 500-0-500 ua ±2%    | 2901-166231               | 89536 | 2901-166231          | 1            |              |             |
| S1            | Switch, toggle, DPST, 8A, 250V  | 5106-114835               | 04009 | 81024-GB             | 1            |              |             |
| S2            | Switch, toggle, DPDT, 15A, 115V | 5106-157883               | 73559 | 2GL50-63             | 1            |              |             |
|               | Fuseholder                      | 2102-100107               | 03614 | HKP                  | 1            |              |             |
|               | Handle, 6-7/16"                 | 2404-101584               | 05704 | 805                  | 2            |              |             |
|               | Cap, H.V. connector             | 3155-172122               | 89536 | 3155-172122          | REF          |              |             |

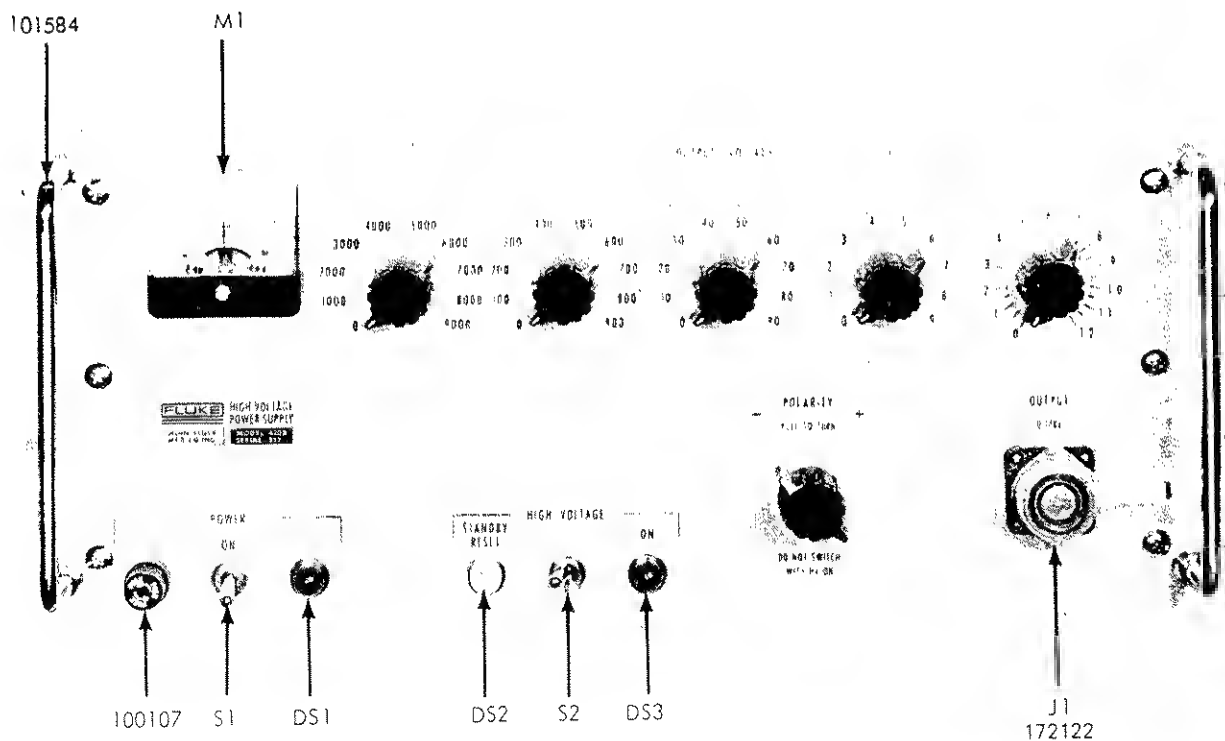



Figure 5-2. FRONT PANEL ASSEMBLY



| REF<br>DESIG.        | DESCRIPTION                               | FLUKE<br>STOCK NO.        | MFR.  | MFR.<br>PART NO. | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|----------------------|---|---------------------------|-------|------------------|--------------|--------------|-------------|
|                      | Switch PCB Assembly                       | 1702-175679<br>(410B-401) | 89536 | 1702-175679      | REF          |              |             |
| C102                 | Cap, elect, 10 uf -10/+75%, 150V          | 1502-106351               | 56289 | 30D106G150DF4    | 1            | 1            |             |
| R104                 | Res, var, WW, 1K $\pm$ 20%, 1-1/4W        | 4702-113266               | 71450 | Type 110         | 1            |              |             |
| R105                 | Res, WW, 1.02K $\pm$ 0.1%, 1/2W           | 4707-145128               | 89536 | 4707-145128      | 1            |              | A           |
| R106                 | Res, WW, 40K $\pm$ 0.02%, 1/2W            | 4707-146530               | 89536 | 4707-146530      | 1            | 1            | A           |
| R106                 | Res, WW, 41.6K $\pm$ 0.05%, 1 1/2W        | 4707-199778               | 89536 | 4707-199778      | 1            | 1            | B           |
| R107<br>thru<br>R124 | Res, WW, 250K $\pm$ 0.05%, 2W             | 4707-156448               | 89536 | 4707-156448      | 18           | 2            |             |
| R125<br>thru<br>R128 | Res, WW, 100K $\pm$ 0.1%, 1W              | 4707-142349               | 89536 | 4707-142349      | 4            |              |             |
| R129                 | Res, WW, 50K $\pm$ 0.1%, 1W               | 4707-156455               | 89536 | 4707-156455      | 1            |              |             |
| R130<br>thru<br>R133 | Res, WW, 10K $\pm$ 0.1%, 1W               | 4707-131664               | 89536 | 4707-131664      | 1            |              |             |
| R134                 | Res, WW, 5K $\pm$ 0.1%, 1/2W              | 4707-149708               | 89536 | 4707-149708      | 1            |              |             |
| R135<br>thru<br>R138 | Res, met flm, 1K $\pm$ 1%, 1/2W           | 4705-151324               | 75042 | Type CEC-TO      | 6            |              |             |
| R139                 | Res, met flm, 499 $\Omega$ $\pm$ 1%, 1/2W | 4705-151514               | 75042 | Type CEC-TO      | 1            |              |             |
| R140                 | Res, var, WW, 600 $\Omega$ $\pm$ 10%, 2W  | 4702-155523               | 71450 | Type 252         | 1            |              |             |
| R141                 | Res, comp, 4.7 $\Omega$ $\pm$ 5%, 1W      | 4704-109785               | 01121 | GB47G5           | 3            |              |             |
| R142<br>thru<br>R148 | Res, met flm, 2.67M $\pm$ 1%, 2W          | 4705-169391               | 14298 | CM-2             | 7            |              |             |
| R149                 | Res, met flm, 309 $\Omega$ $\pm$ 1%, 1/2W | 4705-172130               | 75042 | Type CEC-TO      | 1            |              |             |
| R150,<br>R151        | Res, var, WW, 3K $\pm$ 20%, 1-1/4W        | 4702-149781               | 71450 | Type 110         | 2            |              |             |
| R152                 | Res, comp, 82 $\Omega$ $\pm$ 5%, 1/2W     | 4704-108746               | 01121 | EB8205           | 1            |              |             |
| R153                 | Res, comp, 4.7 $\Omega$ $\pm$ 5%, 1W      | 4704-109785               | 01121 | GB47G5           | REF          |              |             |
| S4,S5,<br>S6         | Switch section, rot, 1 pole, 10 positions | 5108-155978               | 76854 | 239956-FC        | 3            |              |             |





| REF<br>DESIG.          | DESCRIPTION                                | FLUKE<br>STOCK NO.        | MFR.  | MFR.<br>PART NO. | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|------------------------|--|---------------------------|-------|------------------|--------------|--------------|-------------|
|                        | Amplifier PCB Assembly                     | 1702-175687<br>(410B-402) | 89536 | 1702-175687      | REF          |              |             |
| C201                   | Cap, fxd, cer, 0.0033 uf $\pm 20\%$ , 1KV  | 1501-106674               | 56289 | 5GA-D33          | 1            |              |             |
| C202,<br>C203          | Cap, fxd, elec, 40 uf -10/+100%, 500V      | 1502-106765               | 56289 | Type 66D         | 2            | 1            |             |
| C204                   | Cap, fxd, elec, 200 uf -10/+75%, 12V       | 1502-150284               | 56289 | 30D207G012DF4    | 1            | 1            |             |
| C205,<br>C206          | Cap, fxd, cer, 0.1 uf -20/+80%, 500V       | 1501-105684               | 56289 | 41C92            | 5            |              |             |
| C207                   | Cap, fxd, cer, 0.0047 uf $\pm 10\%$ , 500V | 1501-106724               | 71590 | CF-472           | 1            |              | E           |
| C207                   | Cap, fxd, cer, 0.005 uf $\pm 20\%$ , 1KV   | 1501-105650               | 56289 | CO23B102H502M    | 1            |              | F           |
| C208,<br>C209          | Cap, fxd, cer, 0.1 uf -20/+80%, 500V       | 1501-105684               | 56289 | 41C92            | REF          |              |             |
| C210                   | Cap, fxd, cer, 0.05 uf -20/+80%, 500V      | 1501-105676               | 56289 | 33C58            | 1            |              |             |
| C211                   | Cap, fxd, elect, 40 uf -10/+75%, 250V      | 1502-161273               | 56289 | 34D406G250GL4    | 1            | 1            |             |
| C212                   | Cap, fxd, cer, 0.01 uf -20/+80%, 500V      | 1501-105668               | 56289 | 29C9B5           | 1            |              |             |
| C215                   | Cap, fxd, cer, 180 pf $\pm 10\%$ , 500V    | 1501-105890               | 71590 | BB60181KS3N      | 1            |              |             |
| C216                   | Cap, fxd, cer, 0.0027 uf GMV, 500V         | 1501-108211               | 72982 | ED-.0027         | 1            |              |             |
| C217                   | Cap, fxd, cer, 0.1 uf -20/+80%, 500V       | 1501-105684               | 58289 | 41C92            | REF          |              |             |
| C218                   | Cap, fxd, cer, 0.01 uf GMV, 1.6KV          | 1501-106930               | 71590 | DD16-103         | 1            |              |             |
| CR201<br>thru<br>CR204 | Diode, silicon, 600 PIV, 1A                | 4802-112383               | 05277 | 1N4822           | 10           | 2            |             |
| CR205                  | Diode, Si, zener, 75V, 0.005A              | 4803-168096               | 81483 | 1N3041A          | 1            | 1            |             |
| CR206,<br>CR207        | Diode, Si, zener, 10V, type 1N961A         | 4803-113324               | 07910 | 1N961A           | 2            | 1            |             |
| CR208                  | Diode, Si, zener, 110V, 0.005A             | 4803-168104               | 81483 | 1N3045A          | 1            | 1            |             |
| CR209                  | Diode, silicon, 600 PIV, 1A                | 4802-112383               | 05277 | 1N4822           | REF          |              | E           |
| CR210,<br>CR211        | Diode, silicon, 100 PIV, 1A                | 4802-116111               | 05277 | 1N4822           | 4            | 1            |             |
| CR213,<br>CR214        | Diode, silicon, 100 PIV, 1A                | 4802-116111               | 05277 | 1N4822           | REF          |              |             |
| CR215                  | Diode, Si, 200 PIV, 12A                    | 4802-188854               | 04713 | MR1112           | 1            | 1            |             |
| CR216,<br>CR217        | Diode, silicon, 600 PIV, 1A                | 4802-112383               | 05277 | 1N4822           | REF          |              | F           |
| DS201<br>thru<br>DS204 | Lamp, neon, Type NE2E                      | 3902-100347               | 71744 | NE2E             | 4            | 2            |             |
| Q201,<br>Q202          | Transistor, NPN, Si, Type 2N3053           | 4805-150359               | 95303 | 2N3053           | 2            | 1            |             |

| REF<br>DESIG           | DESCRIPTION   | STOCK<br>NO  | MFR   | MFR<br>PART NO | TOT<br>QTY | REC<br>QTY | USE<br>CODE |
|------------------------|---|--|-------|----------------|------------|------------|-------------|
| Q203,<br>Q204          | Transistor, NPN, Si                                       | 4805-203489  | 07910 | CDQ10656       | 3          | 2          |             |
| Q205,<br>Q206          | Transistor, NPN, Si                                       | 4805-203489  | 07910 | CDQ10656       | REF        |            | C           |
| Q205,<br>Q206          | Transistor, NPN, Si                                       | 4819-168716  | 07263 | S19254         | 2          |            | D           |
| Q208,<br>Q209,<br>Q210 | Transistor, PNP, Si                                       | 4805-190389  | 04713 | SM4144         | 3          | 1          | C           |
| Q208,<br>Q209,<br>Q210 | Transistor, PNP, Si                                       | 4805-159491  | 04713 | SS7504         | 3          |            | D           |
| Q211,<br>Q212          | Transistor, NPN, Si                                       | 4805-203489  | 07910 | CDQ10656       | REF        |            |             |
| Q213,<br>Q214          | Transistor, NPN, Si                                       | 4805-203489  | 07910 | CDQ10656       | REF        |            | C           |
| Q213,<br>Q214          | Transistor, NPN, Si                                       | 4805-235812  | 89536 | 4805-235812    | 2          |            | D           |
| R201                   | Res, comp, $10\Omega \pm 10\%$ , 1/2W                     | 4704-108092  | 01121 | EB1001         | 1          |            |             |
| R202,<br>R203          | Res, WW, $30K \pm 5\%$ , 10W                              | 4706-155432  | 06136 | 10F-30000      | 2          |            |             |
| R204                   | Res, comp, $75\Omega \pm 5\%$ , 1/2W                      | 4704-108753  | 01121 | EB7505         | 1          |            |             |
| R205                   | Res, comp, $150K \pm 10\%$ , 1W                           | 4704-109801  | 01121 | GB1541         | 1          |            |             |
| R206                   | Res, comp, $2.7K \pm 10\%$ , 2W                           | 4704-110148  | 01121 | HB2721         | 1          |            | C           |
| R206                   | Res, comp, $2.2K \pm 10\%$ , 2W                           | 4704-109967  | 01121 | HB2221         | 1          |            | D           |
| R207,<br>R208          | Res, comp, $6.2K \pm 5\%$ , 1/2W                          | 4704-108621  | 01121 | EB6225         | 2          |            |             |
| R209                   | Res, met flm, $20K \pm 1\%$ , 1/2W<br>(not illustrated)   | 4705-162438  | 75042 | Type CEC-TO    | 1          |            |             |
| R210                   | Res, met flm, $100K \pm 1\%$ , 1/2W<br>(not illustrated)  | 4705-151316  | 75042 | Type CEC-TO    | 1          |            |             |
| R211                   | Res, comp, $47K \pm 10\%$ , 1/2W                          | 4704-108480  | 01121 | EB4731         | 2          |            |             |
| R212                   | Res, comp, $2.7K \pm 5\%$ , 1/2W                          | 4704-108837  | 01121 | EB2721         | 1          |            |             |
| R213                   | Res, met flm, $40.2K \pm 1\%$ , 1/2W<br>(not illustrated) | 4705-161059  | 75042 | Type CEC-TO    | 1          |            |             |
| R214                   | Res, met flm, $80.6K \pm 1\%$ , 1/2W                      | 4705-150680  | 75042 | Type CEC-TO    | 1          |            |             |
| R215                   | Res, comp, $180K \pm 10\%$ , 1/2W                         | 4704-108431  | 01121 | EB1841         | 1          |            |             |
| R216                   | Res, comp, $82K \pm 10\%$ , 1/2W                          | 4704-108498  | 01121 | EB8231         | 2          |            |             |
| R217                   | Res, comp, $39K \pm 10\%$ , 1/2W<br>(not illustrated)     | 4704-108555  | 01121 | EB3931         | 1          |            |             |
| R218                   | Res, comp, $330\Omega \pm 10\%$ , 1/2W                    | 4704-108589  | 01121 | EB3311         | 1          |            |             |
| R219                   | Res, WW, $14K \pm 5\%$ , +4500 PPM/ $^{\circ}$ C          | 4707-172072  | 89536 | 4707-172072    | 1          |            | A           |
| R219                   | Factory selected part                                     |  |       |                |            |            | B           |

| REF<br>DESIG  | DESCRIPTION  | STOCK<br>NO  | MFR   | MFR<br>PART NO | TOT<br>QTY | REC<br>QTY | USE<br>CODE |
|---------------|--|--|-------|----------------|------------|------------|-------------|
| R220          | Res, WW, 5K $\pm 0.1\%$ , 1/2W                               | 4707-149708  | 89536 | 4707-149708    | REF        |            | A           |
| R221          | Res, WW, 4K $\pm 0.03\%$ , 1/2W                              | 4707-131672  | 89536 | 4707-131672    | 1          | 1          | A           |
| R221          | Factory selected part  |    |       |                |            |            | B           |
| R222          | Res, comp, 10K $\pm 10\%$ , 1W                               | 4704-109389  | 01121 | GB1031         | 1          |            |             |
| R223,<br>R224 | Res, comp, 47 $\Omega$ $\pm 10\%$ , 1/2W                     | 4704-108688  | 01121 | EB4701         | 2          |            |             |
| R226          | Res, comp, 68K $\pm 10\%$ , 2W                               | 4704-110114  | 01121 | HB6831         | 1          |            |             |
| R227          | Res, comp, 1K $\pm 10\%$ , 1/2W                              | 4704-108563  | 01121 | EB1021         | 1          |            |             |
| R228,<br>R229 | Res, comp, 82K $\pm 10\%$ , 1/2W                             | 4704-108498  | 01121 | EB8231         | REF        |            |             |
| R230          | Res, comp, 270 $\Omega$ $\pm 5\%$ , 1/2W                     | 4704-159616  | 01121 | EB2715         | 1          |            |             |
| R231          | Res, comp, 680 $\Omega$ $\pm 10\%$ , 1/2W                    | 4704-108712  | 01121 | EB6811         | 1          |            |             |
| R232          | Res, comp, 47K $\pm 10\%$ , 1/2W                             | 4704-108480  | 01121 | EB4731         | REF        |            |             |
| R233          | Res, comp, 4.7K $\pm 10\%$ , 1/2W                            | 4704-108381  | 01121 | EB4721         | 2          |            |             |
| R234          | Res, comp, 100K $\pm 10\%$ , 1/2W                            | 4704-108126  | 01121 | EB1041         | 1          |            |             |
| R235          | Res, comp, 4.7K $\pm 10\%$ , 1/2W                            | 4704-108381  | 01121 | EB4721         | REF        |            |             |
| R236          | Res, met flm, 1K $\pm 1\%$ , 1/2W                            | 4705-151324  | 75042 | Type CEC-TO    | REF        |            |             |
| R237,<br>R238 | Res, comp, 270K $\pm 10\%$ , 1/2W                            | 4704-108258  | 01121 | EB2741         | 2          |            |             |
| R239          | Res, comp, 1.2M $\pm 10\%$ , 1/2W                            | 4704-108407  | 01121 | EB1251         | 1          |            |             |
| R240          | Res, comp, 2.7 $\Omega$ $\pm 10\%$ , 1W<br>(not illustrated) | 4704-109850  | 01121 | GB27G1         | 1          |            |             |
| R241          | Res, comp, 4.7 $\Omega$ $\pm 5\%$ , 1W                       | 4704-109785  | 01121 | EB47G5         | REF        |            |             |
| R242          | Res, comp, 2.2K $\pm 10\%$ , 1/2W                            | 4704-108605  | 01121 | EB2221         | 1          |            |             |
| R243          | Res, met flm, 1K $\pm 1\%$ , 1/2W<br>(not illustrated)       | 4705-151324  | 75042 | Type CEC-TO    | 1          |            |             |
| V201<br>V201  | Electron Tube, volt. ref, Type 83A1<br>Factory selected      | 5701-170076  | 89536 | 5701-170076    | 1          | 1          | A<br>B      |
|               |  |  |       |                |            |            |             |



R221, R219, and V201 constitute a factory selected and matched set. For replacement, order part number 239707.



| REF<br>DESIG.  | DESCRIPTION                        | FLUKE<br>STOCK NO.        | MFR.  | MFR.<br>PART NO. | TOT.<br>QTY. | REC.<br>QTY. | USE<br>CODE |
|--|------------------------------------|---------------------------|-------|------------------|--------------|--------------|-------------|
| CR301<br>thru<br>CR304<br><br>K302<br><br>K303<br><br>R301 | Time Delay PCB Assembly            | 1702-175695<br>(410B-403) | 89536 | 1702-175695      | REF          |              |             |
|  | Diode, silicon, 600 PIV, 1A        | 4802-112383               | 05277 | IN4822           | REF          |              |             |
|  | Relay, armature, DPDT, 230 VAC, 5A | 4504-148940               | 73949 | A410-060713-00   | 1            |              |             |
|  | Reed switch                        | 4501-169698               | 89536 | 4501-169698      | 1            |              |             |
|  | Res, WW, 1K $\pm 5\%$ , 10W        | 4706-157933               | 06136 | 10F-1000         | 1            |              |             |

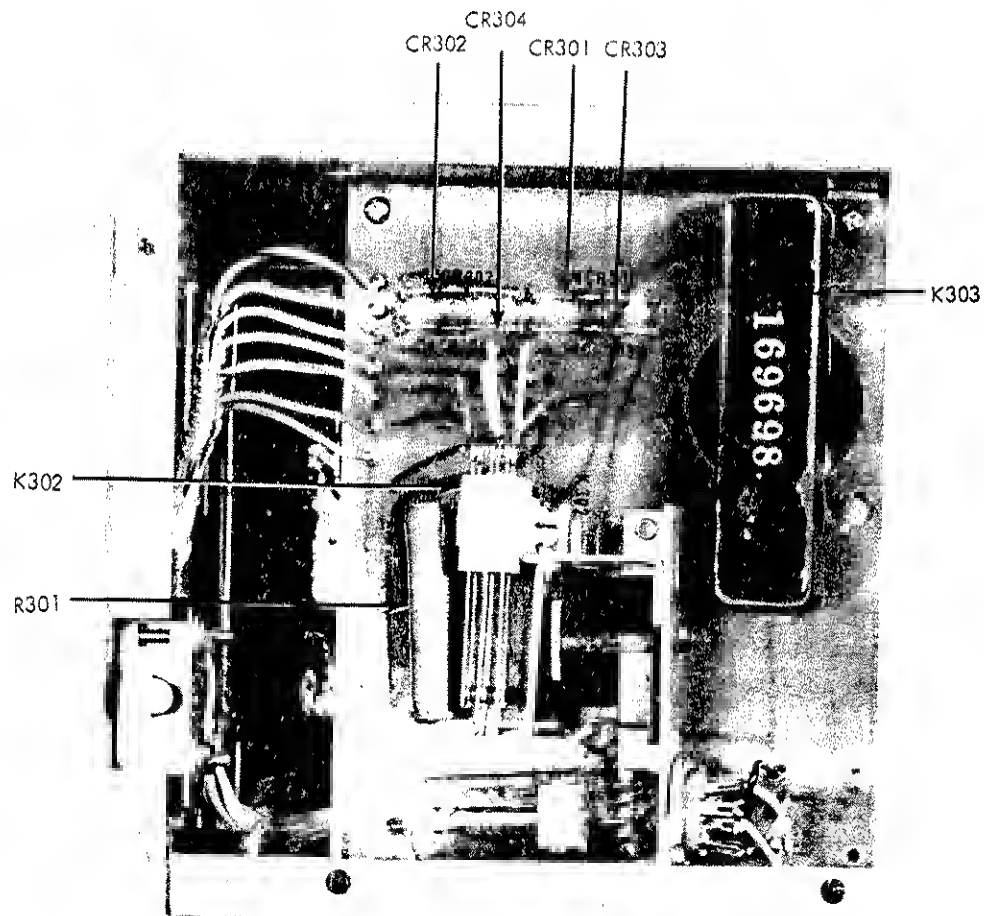


Figure 5-5. TIME DELAY CIRCUIT BOARD ASSEMBLY

## 5-11. USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

| USE<br>CODE | EFFECTIVITY   |
|-------------|---|
| No<br>Code  | Model 410B serial number 123 and on.                  |
| A           | Model 410B serial number 123 thru 812.                |
| B           | Model 410B serial number 813 and on.                  |
| C           | Model 410B serial number 123 thru 1072.               |
| D           | Model 410B serial number 1073 and on.                 |
| E           | Model 410B serial number 123 thru approximately 1331. |
| F           | Model 410B serial number approximately 1332 and on.   |

## Section 7

# General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

## List of Abbreviations and Symbols

|                 |                             |                   |                            |                   |   |
|-----------------|-----------------------------|-------------------|----------------------------|-------------------|---|
| <b>A or amp</b> | ampere                      | <b>hf</b>         | high frequency             | <b>(+) or pos</b> | positive  |
| <b>ac</b>       | alternating current         | <b>Hz</b>         | hertz                      | <b>pot</b>        | potentiometer                                       |
| <b>af</b>       | audio frequency             | <b>IC</b>         | integrated circuit         | <b>p-p</b>        | peak-to-peak  |
| <b>a/d</b>      | analog-to-digital           | <b>if</b>         | intermediate frequency     | <b>ppm</b>        | parts per million                                   |
| <b>assy</b>     | assembly                    | <b>in</b>         | inch(es)                   | <b>PROM</b>       | programmable read-only memory                       |
| <b>AWG</b>      | american wire gauge         | <b>intl</b>       | internal                   | <b>psi</b>        | pound-force per square inch                         |
| <b>B</b>        | bel                         | <b>I/O</b>        | input/output               | <b>RAM</b>        | random-access memory                                |
| <b>bcd</b>      | binary coded decimal        | <b>k</b>          | kilo (10 <sup>3</sup> )    | <b>rf</b>         | radio frequency                                     |
| <b>°C</b>       | Celsius                     | <b>kHz</b>        | kilohertz                  | <b>rms</b>        | root mean square                                    |
| <b>cap</b>      | capacitor                   | <b>kΩ</b>         | kilohm(s)                  | <b>ROM</b>        | read-only memory                                    |
| <b>ccw</b>      | counterclockwise            | <b>kV</b>         | kilovolt(s)                | <b>s or sec</b>   | second (time)                                       |
| <b>cer</b>      | ceramic                     | <b>lf</b>         | low frequency              | <b>scope</b>      | oscilloscope  |
| <b>cermet</b>   | ceramic to metal(seal)      | <b>LED</b>        | light-emitting diode       | <b>SH</b>         | shield  |
| <b>ckt</b>      | circuit                     | <b>LSB</b>        | least significant bit      | <b>SI</b>         | silicon   |
| <b>cm</b>       | centimeter                  | <b>LSD</b>        | least significant digit    | <b>serno</b>      | serial number                                       |
| <b>cmrr</b>     | common mode rejection ratio | <b>M</b>          | mega (10 <sup>6</sup> )    | <b>sr</b>         | shift register                                      |
| <b>comp</b>     | composition                 | <b>m</b>          | milli (10 <sup>-3</sup> )  | <b>Ta</b>         | tantalum  |
| <b>cont</b>     | continue                    | <b>mA</b>         | milliamper(e)s             | <b>tb</b>         | terminal board                                      |
| <b>crt</b>      | cathode-ray tube            | <b>max</b>        | maximum                    | <b>tc</b>         | temperature coefficient or temperature compensating |
| <b>cw</b>       | clockwise                   | <b>mf</b>         | metal film                 | <b>tcxo</b>       | temperature compensated crystal oscillator          |
| <b>d/a</b>      | digital-to-analog           | <b>MHz</b>        | megahertz                  | <b>tp</b>         | test point  |
| <b>dac</b>      | digital-to-analog converter | <b>min</b>        | minimum                    | <b>u or μ</b>     | micro (10 <sup>-6</sup> )                           |
| <b>dB</b>       | decibel                     | <b>mm</b>         | millimeter                 | <b>uhf</b>        | ultra high frequency                                |
| <b>dc</b>       | direct current              | <b>ms</b>         | millisecond                | <b>us or μs</b>   | microsecond(s) (10 <sup>-6</sup> )                  |
| <b>dmm</b>      | digital multimeter          | <b>MSB</b>        | most significant bit       | <b>uut</b>        | unit under test                                     |
| <b>dvm</b>      | digital voltmeter           | <b>MSD</b>        | most significant digit     | <b>V</b>          | volt  |
| <b>elect</b>    | electrolytic                | <b>MTBF</b>       | mean time between failures | <b>v</b>          | voltage   |
| <b>ext</b>      | external                    | <b>MTTR</b>       | mean time to repair        | <b>var</b>        | variable  |
| <b>F</b>        | farad                       | <b>mV</b>         | millivolt(s)               | <b>vco</b>        | voltage controlled oscillator                       |
| <b>°F</b>       | Fahrenheit                  | <b>mv</b>         | multivibrator              | <b>vhf</b>        | very high frequency                                 |
| <b>FET</b>      | Field-effect transistor     | <b>MΩ</b>         | megohm(s)                  | <b>vlf</b>        | very low frequency                                  |
| <b>ff</b>       | flip-flop                   | <b>n</b>          | nano (10 <sup>-9</sup> )   | <b>W</b>          | watt(s)   |
| <b>freq</b>     | frequency                   | <b>na</b>         | not applicable             | <b>ww</b>         | wire wound  |
| <b>FSN</b>      | federal stock number        | <b>NC</b>         | normally closed            | <b>xfrm</b>       | transformer   |
| <b>g</b>        | gram                        | <b>(-) or neg</b> | negative                   | <b>xstr</b>       | transistor  |
| <b>G</b>        | giga (10 <sup>9</sup> )     | <b>NO</b>         | normally open              | <b>xtal</b>       | crystal   |
| <b>gd</b>       | guard                       | <b>ns</b>         | nanosecond                 | <b>xtlo</b>       | crystal oscillator                                  |
| <b>Ge</b>       | germanium                   | <b>opnl ampl</b>  | operational amplifier      | <b>Ω</b>          | ohm(s)  |
| <b>GHz</b>      | gigahertz                   | <b>p</b>          | pico (10 <sup>-12</sup> )  | <b>μ</b>          | micro (10 <sup>-6</sup> )                           |
| <b>gmw</b>      | guaranteed minimum value    | <b>para</b>       | paragraph                  |                   |   |
| <b>gnd</b>      | ground                      | <b>pcb</b>        | printed circuit board      |                   |   |
| <b>H</b>        | henry                       | <b>pF</b>         | picofarad                  |                   |   |
| <b>hd</b>       | heavy duty                  | <b>pn</b>         | part number                |                   |   |



# Federal Supply Codes for Manufacturers

|  |   |  |   |
|--|---|--|---|
| D9816<br>Westermann Wilhelm Augusta-Anlage<br>Mannheim-Nackarau Germany                          | 02533<br>Leigh Instruments Ltd.<br>Frequency Control Div.<br>Don Mills, Ontario, Canada                   | 04713<br>Motorola Inc.<br>Semiconductor Group<br>Phoenix, Arizona                            | 06665<br>Precision Monolithics<br>Sub of Bourns Inc.<br>Santa Clara, California                     |
| 00199<br>Marcon Electronics Corp<br>Kearny, New Jersey   | 02606<br>Fenwal Labs<br>Division of Travonai Labs<br>Morton Grove, Illinois                               | 05236<br>Jonathan Mfg. Co.<br>Fullerton, California  | 06666<br>General Devices Co. Inc.<br>Indianapolis, Indiana  |
| 00213<br>Nytronics Corp. Group Inc.<br>Darlington, South Carolina                                | 0266<br>Bunker Ramo-Eltra Corp.<br>Amphonol NA Div.<br>Broadview, Illinois                                | 05245<br>Corcom Inc.<br>Libertyville, Illinois   | 06739<br>Electron Corp.<br>Littleton, Colorado  |
| 00327<br>Welwyn International Inc.<br>Westlake, Ohio   | 02735<br>RCA-Solid State Div.<br>Somerville, New Jersey   | 05276<br>ITT Pomona<br>Electronics Div.<br>Pomona, California                                | 06743<br>Gould Inc.<br>Foil Div.<br>Eastlake, Ohio  |
| 00656<br>Aerovox Corp.<br>New Bedford, Massachusetts   | 02799<br>Arco Electronics Inc.<br>Chatsworth, California  | 05277<br>Westinghouse Elec. Corp.<br>Semiconductor Div.<br>Youngwood, Pennsylvania           | 06751<br>Components Inc.<br>Sensor Div.<br>Phoenix, Arizona   |
| 00686<br>Film Capacitors Inc.<br>Passaic, New Jersey   | 03508<br>General Electric Co.<br>Semiconductor Products & Batteries<br>Auburn, New York                   | 05397<br>Union Carbide Corp.<br>Materials Systems Div.<br>Cleveland, Ohio                    | 06776<br>Robinson Nugent Inc.<br>New Albany, Indiana  |
| 00779<br>AMP, Inc.<br>Harrisburg, Pennsylvania   | 03797<br>Genisco Technology Corp.<br>Eltronics Div.<br>Rancho Dominguez, Calif.                           | 05571<br>Sprague Electric Co.<br>(Now 56289)   | 06915<br>Richco Plastic Co.<br>Chicago, Illinois  |
| 01121<br>Allen Bradley Co.<br>Milwaukee, Wisconsin   | 03877<br>Gilbert Engineering Co. Inc.<br>Incon Sub of Transatron<br>Electronic Corp.<br>Glendale, Arizona | 05574<br>Viking Connectors Inc.<br>Sub of Criton Corp.<br>Chatsworth, Calif.                 | 06961<br>Vernitron Corp.<br>Piezo Electric Div.<br>Bedford, Ohio                                    |
| 01281<br>TRW Electronics & Defense Sector<br>Lawndale, California                                | 03888<br>KDI Electronics Inc.<br>Pyrofilm Div.<br>Whippany, New Jersey                                    | 05820<br>EG & G Wakefield Engineering<br>Wakefield, Massachusetts                            | 06980<br>Varian Associates Inc.<br>Eimac Div.<br>San Carlos, California                             |
| 01295<br>Texas Instruments Inc.<br>Semiconductor Group<br>Dallas, Texas                          | 03911<br>Clairex Corp.<br>Clairex Electronics Div.<br>Mount Vernon, New York                              | 05972<br>Loctite Corp.<br>Newington, Connecticut   | 07047<br>Ross Milton Co., The<br>Southampton, Penna.  |
| 01537<br>Motorola Communications &<br>Electronics Inc.<br>Franklin Park, Illinois                | 03980<br>Muirhead Inc.<br>Mountainside, New Jersey  | 06001<br>General Electric Co.<br>Electric Capacitor Product Section<br>Columbia, S. Carolina | 07138<br>Westinghouse Electric Corp.<br>Industrial & Government<br>Tube Div.<br>Hempstead, New York |
| 01686<br>RCL Electronics/Shalleross Inc.<br>Electro Components Div.<br>Manchester, New Hampshire | 04009<br>Cooper Industries, Inc.<br>Arrow Hart Div.<br>Hartford, Connecticut                              | 06141<br>Fairchild Weston Systems Inc.<br>Data Systems Div.<br>Sarasota, Florida             | 07233<br>Benchmark Technology Inc.<br>City of Industry, Calif.                                      |
| 01884<br>Sprague Electric Co.<br>(Now 56289)   | 04217<br>Essex International Inc.<br>Wire & Cable Div.<br>Anaheim, California                             | 06192<br>La Deau Mfg. Co.<br>Glendale, California  | 07239<br>Biddle Instruments<br>Blue Bell, Penna.  |
| 01961<br>Varian Associates Inc.<br>Pulse Engineering Div.<br>Conroy, Connecticut                 | 04221<br>Midland-Ross Corp.<br>Midtex Div.<br>N. Mankato, Minnesota                                       | 06229<br>Electrovert Inc.<br>Elmsford, New York  | 07256<br>Silicon Transistor Corp.<br>Sub of BBF Inc.<br>Chelmsford, Massachusetts                   |
| 02111<br>Spectrol Electronics Corp.<br>City of Industry, California                              | 04222<br>AVX Corp.<br>AVX Ceramics Div.<br>Myrtle Beach, S. Carolina                                      | 06383<br>Panduit Corp.<br>Tinley Park, Illinois  | 07261<br>Avnet Corp.<br>Culver City, California   |
| 02114<br>Amperex Electronic Corp.<br>Ferrox Cube Div.<br>Saugerties, New York                    | 04423<br>Telonic Berkley Inc.<br>Laguna Beach, California   | 06473<br>Bunker Ramo Corp.<br>Amphonol NA Div.<br>SAMS Operation<br>Chatsworth, California   | 07263<br>Fairchild Camera & Instrument<br>Semiconductor Div.<br>Mountain View, California           |
| 02131<br>General Instrument Corp. Government<br>Systems Div.<br>Westwood, Massachusetts          |   | 06555<br>Beede Electrical Instrument<br>Penacook, New Hampshire                              | 07344<br>Bircher Co. Inc., The<br>Rochester, New York   |
| 02395<br>Sonar Radio Corp.<br>Hollywood, Florida   |   |  |   |

# Federal Supply Codes for Manufacturers (cont)

|   |  |   |   |
|---|--|---|---|
| 07557<br>Campion Co. Inc.<br>Philadelphia, Penna.   | 09423<br>Scientific Components Inc.<br>Santa Barbara, California                           | 11711<br>General Instrument Corp.<br>Rectifier Div.<br>Hicksville, New York                   | 12954<br>Microsemi Corp.<br>Components Group<br>Scottsdale, Arizona   |
| 07597<br>Burdny Corp.<br>Tape/Cable Div.<br>Rochester, New York                             | 09579<br>CTS of Canada, Ltd<br>Streetsville, Ontario                                       | 11726<br>Qualidyne Corp.<br>Santa Clara, California   | 12969<br>Unitrode Corp.<br>Lexington, Massachusetts   |
| 07716<br>TRW Inc. (Can use 11502)<br>IRC Fixed Resistors/<br>Burlington<br>Burlington, Iowa | 09922<br>Burdny Corp.<br>Norwalk, Connecticut  | 12014<br>Chicago Rivet & Machine Co.<br>Naperville, Illinois                                  | 13050<br>Potter Co.<br>Wesson, Mississippi  |
| 07792<br>Lema Engineering Corp.<br>Northampton, Massachusetts                               | 09969<br>Dale Electronics Inc.<br>Yankton, South Dakota                                    | 12040<br>National Semiconductor Corp.<br>Danbury, Connecticut                                 | 13103<br>Thermalloy Co., Inc.<br>Dallas, Texas  |
| 07810<br>Bock Corp.<br>Madison, Wisconsin   | 09975<br>Burroughs Corp.<br>Electronics Components<br>Detroit, Michigan                    | 12060<br>Diodes Inc.<br>Northridge, California  | 13327<br>Solitron Devices Inc.<br>Tappan, New York  |
| 07933<br>Raytheon Co.<br>Semiconductor Div.<br>Mountain View, Calif.                        | 10059<br>Barker Engineering Corp.<br>Kenilworth, New Jersey                                | 12136<br>PLC Industries Inc.<br>Formerly Philadelphia Handle Co.<br>Camden, New Jersey        | 13511<br>Bunker-Ramo Corp.<br>Amphenol Cadre Div.<br>Los Gatos, California  |
| 08235<br>Industro Transistor Corp.<br>Long Island City, New York                            | 10389<br>Illinois Tool Works Inc.<br>Licon Div.<br>Chicago, Illinois                       | 12300<br>AMF Canada Ltd.<br>Potter-Brumfield<br>Guelph, Ontario, Canada                       | 13606<br>Sprague Electric Co.<br>(Use 56289)  |
| 08261<br>Spectra-Strip<br>An Eltra Co.<br>Garden Grove, Calif.                              | 10582<br>CTS of Asheville<br>Skyland, N. Carolina  | 12323<br>Practical Automation Inc.<br>Shelton, Connecticut                                    | 13689<br>SPS Technologies Inc.<br>Hatfield, Pennsylvania  |
| 08530<br>Reliance Mica Corp.<br>Brooklyn, New York  | 11236<br>CTS Corp.<br>Berne Div.<br>Berne, Indiana   | 12327<br>Freeway Corp.<br>Cleveland, Ohio   | 13919<br>Burr-Brown Research Corp.<br>Tucson, Arizona   |
| 08718<br>ITT Cannon Electric<br>Phoenix Div.<br>Phoenix, Arizona                            | 11237<br>CTS Corp of California<br>Paso Robles Div.<br>Paso Robles, California             | 12443<br>Budd Co., The<br>Plastics Products Div.<br>Phoenixville, Pennsylvania                | 14099<br>Semtech Corp.<br>Newbury Park, California  |
| 08806<br>General Electric Co.<br>Miniature Lamp Products<br>Cleveland, Ohio                 | 11295<br>ECM Motor Co.<br>Schaumburg, Illinois   | 12581<br>Hitachi Metals International Ltd.<br>Hitachi Magna-Lock Div.<br>Big Rapids, Missouri | 14140<br>McGray-Edison Co.<br>Commercial Development Div.<br>Manchester, New Hampshire                                |
| 08863<br>Nylomatic<br>Fallsington, Penna.   | 11358<br>Columbia Broadcasting System<br>CBS Electronic Div.<br>Newburyport, Massachusetts | 12515<br>US Terminals Inc.<br>Cincinnati, Ohio  | 14193<br>Cal-R-Inc.<br>Santa Monica, California   |
| 08988<br>Skottie Electronics Inc.<br>Archbald, Pennsylvania                                 | 11403<br>Vacuum Can Co. Best Coffee Maker Div.<br>Chicago, Illinois                        | 12615<br>Hamlin Inc.<br>Lake Mills, Wisconsin   | 14298<br>American Components Inc.<br>an Insilco Co. RPC Div.<br>Conshohocken, Pennsylvania                            |
| 09021<br>Aircor Inc.<br>Aircor Electronics<br>Bradford, Penna.                              | 11502<br>TRW Inc.<br>TRW Resistive Products Div.<br>Boone, North Carolina                  | 12617<br>Clarostat Mfg. Co. Inc.<br>Dover, New Hampshire                                      | 14298<br>ACIC Inc.<br>Sub of Insilco Corp.<br>Research Triangle Park, NC  |
| 09023<br>Cornell-Dublier Electronics<br>Fuquay-Varina, N. Carolina                          | 11503<br>Keystone Columbia Inc.<br>Freemont, Indiana                                       | 12697<br>James Electronic Inc.<br>Chicago, Illinois   | 14329<br>Wells Electronics Inc.<br>South Bend, Indiana  |
| 09214<br>General Electric Co.<br>Semiconductor Products Dept.<br>Auburn, New York           | 11532<br>Teledyne Relays Teledyne<br>Industries Inc.<br>Hawthorne, California              | 12856<br>MicroMetals Inc.<br>Anaheim, California  | 14482<br>Watkins-Johnson Co.<br>Palo Alto, California   |
| 09353<br>C and K Components Inc.<br>Newton, Massachusetts                                   |  | 12881<br>Metex Corp.<br>Edison, New Jersey  | 14552<br>Microsemi Corp.<br>Santa Ana, California   |
|   |  | 12895<br>Cleveland Electric Motor Co.<br>Cleveland, Ohio                                      | 14655<br>Cornell-Dublier Electronics<br>Div. of Federal Pacific<br>Electric Co. Govt Cont Dept.<br>Newark, New Jersey |

# Federal Supply Codes for Manufacturers (cont)

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|---|---|--|---|
| 14704<br>Crydom Controls<br>(Division of Int Rectifier)<br>El Segundo, California           | 16733<br>Cablewave Systems Inc.<br>North Haven, Connecticut                                     | 18927<br>GTE Products Corp.<br>Precision Material Products<br>Business Parts Div.<br>Titusville, Pennsylvania                  | 23936<br>William J. Purdy Co.<br>Pamotor Div.<br>Burlingame, California                               |
| 14752<br>Electro Cube Inc.<br>San Gabriel, California                                       | 16742<br>Paramount Plastics<br>Fabricators Inc.<br>Downey, California                           | 19315<br>Bendix Corp., The<br>Navigation & Control Group<br>Terboro, New Jersey  | 24347<br>Penn Engineering Co.<br>S. El Monte, California  |
| 14936<br>General Instrument Corp.<br>Discrete Semi Conductor Div.<br>Hicksville, New York   | 16758<br>General Motors Corp.<br>Delco Electronics Div.<br>Kokomo, Indiana                      | 19451<br>Perine Machinery & Supply Co.,<br>Kent, Washington  | 24355<br>Analog Devices Inc.<br>Norwood, Massachusetts  |
| 14949<br>Trompeter Electronics<br>Chatsworth, California                                    | 17069<br>Circuit Structures Lab<br>Burbank, California  | 19613<br>Minnesota Mining & Mfg. Co.<br>Textool Products Dept.<br>Electronic Product Div.<br>Irving, Texas                     | 24444<br>General Semiconductor<br>Industries, Inc.<br>Tempe, Arizona                                  |
| 15412<br>Amtron<br>Midlothian, Illinois   | 17117<br>Electronic Molding Corp.<br>Woonsocket, Rhode Island                                   | 19647<br>Caddock Electronics Inc.<br>Riverside, California   | 24655<br>Genrad Inc.<br>Concord, Massachusetts  |
| 15542<br>Scientific Components Corp.<br>Mini-Circuits Laboratory Div.<br>Brooklyn, New York | 17338<br>High Pressure Eng. Co. Inc.<br>Oklahoma City, Oklahoma                                 | 19701<br>Mepco/Centralab Inc.<br>A N. American Phillips Co.<br>Mineral Wells, Texas  | 24759<br>Lenox-Fugle Electronics Inc.<br>South Plainfield, New Jersey                                 |
| 15636<br>Elec-Trol Inc.<br>Saugus, California   | 17545<br>Atlantic Semiconductors Inc.<br>Asbury Park, New Jersey                                | 20584<br>Enochs Mfg. Inc.<br>Indianapolis, Indiana   | 24796<br>AMF Inc.<br>Potter & Brumfield Div.<br>San Juan Capistrano, Calif.                           |
| 15782<br>Bausch & Lomb Inc.<br>Graphics & Control Div.<br>Austin, Texas                     | 17745<br>Angstrom Precision, Inc.<br>Hagerstown, Maryland                                       | 20891<br>Cosar Corp.<br>Dallas, Texas  | 24931<br>Specialty Connector Co.<br>Greenwood, Indiana  |
| 15801<br>Fenwal Electronics Inc.<br>Div. of Kidde Inc.<br>Framingham, Massachusetts         | 17856<br>Siliconix Inc.<br>Santa Clara, California  | 21317<br>Electronics Applications Co.<br>El Monte, California  | 25088<br>Siemen Corp.<br>Islen, New Jersey  |
| 15818<br>Teledyne Inc. Co.<br>Teledyne Semiconductor Div.<br>Mountain View, California      | 18178<br>E G & Gvactec Inc.<br>St. Louis, Missouri  | 21604<br>Buckeye Stamping Co.<br>Columbus, Ohio  | 25099<br>Cascade Gasket<br>Kent, Washington   |
| 15849<br>Useco Inc.<br>(Now 88245)  | 18324<br>Signetics Corp.<br>Sacramento, California  | 21845<br>Soliton Devices Inc.<br>Semiconductor Group<br>Rivera Beach, Florida  | 25403<br>Amperex Electronic Corp.<br>Semiconductor & Micro-Circuit Div.<br>Slatersville, Rhode Island |
| 15898<br>International Business<br>Machines Corp.<br>Essex Junction, Vermont                | 18520<br>Sharp Electronics Corp.<br>Paramus, New Jersey   | 22526<br>DuPont, El DeNemours & Co. Inc.<br>DuPont Connector Systems<br>Advanced Products Div.<br>New Cumberland, Pennsylvania | 25706<br>Dabum Electronic & Cable Corp.<br>Norwood, New Jersey  |
| 16245<br>Conap Inc.<br>Olean, New York  | 18542<br>Wabash Inc.<br>Wabash Relay & Electronics Div.<br>Wabash, Indiana                      | 22767<br>ITT Semiconductors<br>Palo Alto, California   | 26629<br>Frequency Sources Inc.<br>Sources Div.<br>Chelmsford, Massachusetts                          |
| 16258<br>Space-Lok Inc.<br>Burbank, California  | 18565<br>Chomerics Inc.<br>Woburn, Massachusetts  | 22784<br>Palmer Inc.<br>Cleveland, Ohio  | 26806<br>American Zettler Inc.<br>Irvine, California  |
| 16352<br>Codi Corp.<br>Linden, New Jersey   | 18612<br>Vishay Intertechnology Inc.<br>Vishay Resistor Products Group<br>Malvern, Pennsylvania | 23050<br>Product Comp. Corp.<br>Mount Vernon, New York   | 27014<br>National Semiconductor Corp.<br>Santa Clara, California                                      |
| 16469<br>MCL Inc.<br>LaGrange, Illinois   | 18632<br>Norton-Chemplast<br>Santa Monica, California   | 23732<br>Tracor Applied Sciences Inc.<br>Rockville, Maryland   | 27167<br>Coming Glass Works Coming<br>Electronics<br>Wilmington, North Carolina                       |
| 16473<br>Cambridge Scientific Industries<br>Div. of Chemed Corp.<br>Cambridge, Maryland     | 18677<br>Scanbe Mfg. Co.<br>Div. of Zero Corp.<br>El Monte, California                          | 23880<br>Stanford Applied Engineering<br>Santa Clara, California   | 27264<br>Molex Inc.<br>Lisle, Illinois  |
|   | 18736<br>Voltronics Corp.<br>East Hanover, New Jersey   |  | 27440<br>Industrial Screw Products<br>Los Angeles, California   |

# Federal Supply Codes for Manufacturers (cont)

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| 27745<br>Associated Spring Barnes Group Inc.<br>Syracuse, New York                                   | 30800<br>General Instrument Corp.<br>Capacitor Div.<br>Hicksville, New York              | 33297<br>NEC Electronics USA Inc.<br>Electronic Arrays Inc. Div.<br>Mountain View, California  | 49956<br>Raytheon Company<br>Executive Offices<br>Lexington, Massachusetts              |
| 27956<br>Relcom (Now 14482)  | 31019<br>Solid State Scientific Inc.<br>Willow Grove, Pennsylvania                       | 33919<br>Nortek Inc.<br>Cranston, Rhode Island   | 50088<br>Thomson Components-Mostek Corp.<br>Carrollton, Texas                           |
| 28198<br>Positronic Industries<br>Springfield, Missouri  | 31091<br>Alpha Industries Inc.<br>Microelectronics Div.<br>Hatfield, Pennsylvania        | 34333<br>Silicon General Inc.<br>Garden Grove, California                                      | 50120<br>Eagle-Picher Industries Inc.<br>Electronics Div.<br>Colorado Springs, Colorado |
| 28213<br>Minnesota Mining & Mfg. Co.<br>Consumer Products Div.<br>3M Center<br>Saint Paul, Minnesota | 31323<br>Metro Supply Company<br>Sacramento, California                                  | 34225<br>Advanced Micro Devices<br>Sunnyvale, California                                       | 50157<br>Midwest Components Inc.<br>Muskegon, Mississippi                               |
| 28425<br>Serv-O-Link<br>Euless, Texas  | 31448<br>Army Safeguard Logistics Command<br>Huntsville, Alabama                         | 34359<br>Minnesota Mining & Mfg. Co.<br>Commercial Office Supply Div.<br>Saint Paul, Minnesota | 50541<br>Hypertronics Corp.<br>Hudson, Massachusetts                                    |
| 28478<br>Deltrol Corporation<br>Deltrol Controls Div.<br>Milwaukee, Wisconsin                        | 31746<br>Cannon Electric<br>Woodbury, Tennessee  | 34371<br>Harris Corp.<br>Harris Semiconductor<br>Products Group<br>Melbourne, Florida          | 50579<br>Litronix Inc.<br>Cupertino, California   |
| 28480<br>Hewlett Packard Co.<br>Corporate HQ<br>Palo Alto, California                                | 31827<br>Budwig<br>Ramona, California  | 34649<br>Intel Corp.<br>Santa Clara, California  | 51167<br>Aries Electronics Inc.<br>Frenchtown, New Jersey                               |
| 28484<br>Emerson Electric Co.<br>Gearmaster Div.<br>McHenry, Illinois                                | 31918<br>ITT-Schadow<br>Eden Prairie, Minnesota  | 34802<br>Electromotive Inc.<br>Kenilworth, New Jersey  | 51372<br>Verbatim Corp.<br>Sunnyvale, California  |
| 28520<br>Heyco Molded Products<br>Kenilworth, New Jersey   | 32293<br>Intersil<br>Cupertino, California   | 34848<br>Hartwell Special Products<br>Placentia, California                                    | 51406<br>Murata Erie, No. America Inc.<br>(Also see 72982)<br>Marietta, Georgia         |
| 29083<br>Monsanto Co.<br>Santa Clara, California   | 32539<br>Mura Corp.<br>Westbury, Long Island, N.Y.                                       | 35009<br>Renfrew Electric Co. Ltd.<br>IRC Div.<br>Toronto, Ontario, Canada                     | 51499<br>Amtron Corp.<br>Boston, Massachusetts  |
| 29604<br>Stackpole Components Co.<br>Raleigh, North Carolina   | 32559<br>Bivar<br>Santa Ana, California  | 36665<br>Mitel Corp.<br>Kanata, Ontario, Canada  | 51605<br>CODI Semiconductor Inc.<br>Kenilworth, New Jersey                              |
| 29907<br>Omega Engineering Inc.<br>Stamford, Connecticut   | 32767<br>Griffith Plastics Corp.<br>Burlingame, California                               | 37942<br>Mallory Capacitor Corp.<br>Sub of Emhart Industries<br>Indianapolis, Indiana          | 51642<br>Centre Engineering Inc.<br>State College, Pennsylvania                         |
| 30035<br>Jolo Industries Inc.<br>Garden Grove, California  | 32879<br>Advanced Mechanical Components<br>Northridge, California                        | 39003<br>Maxim Industries<br>Middleboro, Massachusetts   | 51791<br>Statek Corp.<br>Orange, California   |
| 30146<br>Symbex Corp.<br>Painesville, Ohio   | 32897<br>Murata Erie North America Inc.<br>Carlisle Operations<br>Carlisle, Pennsylvania | 40402<br>Roderstein Electronics Inc.<br>Statesville, North Carolina                            | 51984<br>NEC America Inc.<br>Falls Church, Virginia                                     |
| 30148<br>AB Enterprise Inc.<br>Ahoskie, North Carolina   | 32997<br>Bourns Inc.<br>Trimpot Div.<br>Riverside, California                            | 42498<br>National Radio<br>Melrose, Massachusetts  | 52063<br>Exar Integrated Systems<br>Sunnyvale, California                               |
| 30161<br>Aavid Engineering Inc.<br>Laconia, New Hampshire  | 33096<br>Colorado Crystal Corp.<br>Loveland, Colorado                                    | 43543<br>Nytronics Inc.(Now 53342)   | 52072<br>Circuit Assembly Corp.<br>Irvine, California                                   |
| 30315<br>Iron Corp.<br>San Diego, California   | 33173<br>General Electric Co.<br>Owensboro, Kentucky                                     | 44655<br>Ohmite Mfg. Co.<br>Skokie, Illinois   | 52152<br>Minnesota Mining & Mfg.<br>Saint Paul, Minnesota                               |
| 30323<br>Illinois Tool Works Inc.<br>Chicago, Illinois   | 33246<br>Epoxy Technology Inc.<br>Billerica, Massachusetts                               | 49671<br>RCA Corp.<br>New York, New York   | 52333<br>API Electronics<br>Haugpauge, Long Island, New York                            |

# Federal Supply Codes for Manufacturers (cont)

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|---|--|--|--|
| 52361<br>Communication Systems<br>Piscataway, New Jersey                  | 54590<br>RCA Corp.<br>Electronic Components Div.<br>Cherry Hill, New Jersey          | 58104<br>Simco<br>Atlanta, Georgia   | 64155<br>Linear Technology<br>Milpitas, California                             |
| 52525<br>Space-Lok Inc.<br>Lerco Div.<br>Burbank, California              | 55026<br>American Gage & Machine Co.<br>Simpson Electric Co. Div.<br>Elgin, Illinois | 58474<br>Superior Electric Co.<br>Bristol, Connecticut                                 | 64834<br>West M G Co.<br>San Francisco, Calif.                                 |
| 52531<br>Hitachi Magnetics<br>Edmore, Missouri                            | 55112<br>Plessey Capacitors Inc.<br>(Now 60935)                                      | 59124<br>KOA-Speer Electronics Inc.<br>Bradford, Pennsylvania                          | 65092<br>Sangamo Weston Inc.<br>Weston Instruments Div.<br>Newark, New Jersey  |
| 52745<br>Timco<br>Los Angeles, California                                 | 55261<br>LSI Computer Systems Inc.<br>Melville, New York                             | 59640<br>Supertex Inc.<br>Sunnyvale, California  | 65940<br>Rohm Corp & Whitney<br>Irvine, California                             |
| 52763<br>Stettner-Electronics Inc.<br>Chattanooga, Tennessee              | 55285<br>Beroquist Co.<br>Minneapolis, Minnesota                                     | 59660<br>Tusonix Inc.<br>Tucson, Arizona   | 65964<br>Evov Inc.<br>Bannockburn, Illinois                                    |
| 52769<br>Sprague-Goodman Electronics Inc.<br>Garden City Park, New York   | 55576<br>Synertek<br>Santa Clara, California   | 59730<br>Thomas and Betts Corp.<br>Iowa City, Iowa                                     | 66150<br>Entron Inc.<br>Winslow Teltronics Div.<br>Glendale, New York          |
| 52771<br>Monitorm Corp.<br>Amatrom Div.<br>Santa Clara, California        | 55680<br>Michicon/America/Corp.<br>Schaumburg, Illinois                              | 59831<br>Semtronics Corp.<br>Watchung, New Jersey                                      | 66608<br>Bering Industries<br>Fremont, California                              |
| 52840<br>Western Digital Corp.<br>Costa Mesa, California                  | 56282<br>Utek Systems Inc.<br>Olathe, Kansas   | 60395<br>Xicor Inc.<br>Milpitas, California  | 70290<br>Almetal Universal Joint Co.<br>Cleveland, Ohio                        |
| 53021<br>Sangamo Weston Inc.<br>(See 06141)                               | 56289<br>Sprague Electric Co.<br>North Adams, Massachusetts                          | 60399<br>Torin Engineered Blowers<br>Div. of Clevepak Corp.<br>Torrington, Connecticut | 70485<br>Atlantic India Rubber Works Inc.<br>Chicago, Illinois                 |
| 53217<br>Technical Wire Products Inc.<br>Santa Barbara, California        | 56365<br>Square D Co.<br>Corporate Offices<br>Palatine, Illinois                     | 60705<br>Cera-Mite Corp.<br>(formerly Sprague)<br>Grafton, Wisconsin                   | 70563<br>Amperite Company<br>Union City, New Jersey                            |
| 53342<br>Opt Industries Inc.<br>Phillipsburg, New Jersey                  | 56375<br>DAL Industries Inc.<br>Wescorp Div.<br>Mountain View, California            | 60935<br>Westlake Capacitor Inc.<br>Tantalum Div.<br>Greencastle, Indiana              | 70903<br>Belden Corp.<br>Geneva, Illinois                                      |
| 53944<br>Glow-Lite<br>Pauls Valley, Oklahoma                              | 56481<br>Shugart Associates<br>Sub of Xerox Corp.<br>Sunnyvale, California           | 61804<br>M/A Com Inc.<br>Burlington, Massachusetts                                     | 71002<br>Bimbach Co. Inc.<br>Farmingdale, New York                             |
| 54294<br>Shallcross Inc.<br>Smithfield, North Carolina                    | 56708<br>Zilog Inc.<br>Campbell, California  | 61857<br>SAN-O Industrial Corp.<br>Bohemia, Long Island, NY                            | 71034<br>Bliley Electric Co.<br>Erie, Pennsylvania                             |
| 54453<br>Sullins Electronic Corp.<br>San Marcos, California               | 56856<br>Vamistor Corp. of Tennessee<br>Sevierville, Tennessee                       | 61935<br>Schurter Inc.<br>Petaluma, California   | 71183<br>Westinghouse Electric Corp.<br>Bryant Div.<br>Bridgeport, Connecticut |
| 54473<br>Matsushita Electric Corp.<br>(Panasonic)<br>Secaucus, New Jersey | 56880<br>Magnetics Inc.<br>Baltimore, Maryland                                       | 62351<br>Apple Rubber<br>Lancaster, New York   | 71400<br>Busman Manufacturing<br>Div. McGraw-Edison Co.<br>St. Louis, Missouri |
| 54583<br>TDK<br>Garden City, New York                                     | 57026<br>Endicott Coil Co. Inc.<br>Binghamton, New York                              | 62793<br>Lear Siegler Inc.<br>Energy Products Div.<br>Santa Ana, California            | 71450<br>CTS Corp.<br>Elkhart, Indiana   |
| 54869<br>Piher International Corp.<br>Arlington Heights, Illinois         | 57053<br>Gates Energy Products<br>Denver, Ohio                                       | 63743<br>Ward Leonard Electric Co. Inc.<br>Mount Vernon, New York                      | 71468<br>ITT Cannon Div. of ITT<br>Fountain Valley, California                 |
| 54937<br>DeYoung Mfg.<br>Bellevue, Washington                             | 58014<br>Hitachi Magnalock Corp.<br>(Now 12581)                                      | 64154<br>Lamb Industries<br>Portland, Oregon   | 71482<br>General Instrument Corp.<br>Clare Div.<br>Chicago, Illinois           |

# Federal Supply Codes for Manufacturers (cont)

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|---|---|---|---|
| 71590<br>Mepco/Centralab<br>A North American Philips Co.<br>Fort Dodge, Iowa              | 73445<br>Amperex Electronic Corp.<br>Hicksville, New York                           | 75378<br>CTS Knights Inc.<br>Sandwich, Illinois                                       | 79727<br>C. W Industries<br>Southampton, Pennsylvania   |
| 71707<br>Coto Corp.<br>Providence, Rhode Island   | 73559<br>Carlingswitch Inc.<br>Hartford, Connecticut                                | 75382<br>Kulka Electric Corp.<br>(Now 83330)<br>Mount Vernon, New York                | 79963<br>Zierick Mfg. Corp.<br>Mount Kisco, New York  |
| 71744<br>General Instrument Corp.<br>Lamp Div/Worldwide<br>Chicago, Illinois              | 73586<br>Circle F Industries<br>Trenton, New Jersey                                 | 75915<br>Tracor Littlefuse<br>Des Plaines, Illinois                                   | 80009<br>Tektronix<br>Beaverton, Oregon   |
| 71785<br>TRW Inc.<br>Cinch Connector Div.<br>Elk Grove Village, Illinois                  | 73734<br>Federal Screw Products Inc.<br>Chicago, Illinois                           | 76854<br>Oak Switch Systems Inc.<br>Crystal Lake, Illinois                            | 80031<br>Mepco/Electra Inc.<br>Morristown, New Jersey   |
| 71984<br>Dow Corning Corp.<br>Midland, Michigan   | 73743<br>Fischer Special Mfg. Co.<br>Cold Spring, Kentucky                          | 77122<br>TRW Assemblies & Fasteners Group<br>Fastener Div.<br>Moutainside, New Jersey | 80032<br>Ford Aerospace & Communications Corp.<br>Western Development<br>Laboratories Div.<br>Palo Alto, California |
| 72005<br>AMAX Specialty Metals Corp.<br>Newark, New Jersey                                | 73893<br>Microdot<br>Mt. Clemens, Mississippi                                       | 77342<br>AMF Inc.<br>Potter & Brumfield Div.<br>Princeton, Indiana                    | 80145<br>LFE Corp.<br>Process Control Div.<br>Clinton, Ohio   |
| 72136<br>Electro Motive Mfg. Corp.<br>Florence, South Carolina                            | 73899<br>JFD Electronic Components<br>Div. of Murata Erie<br>Occanside, New York    | 77542<br>Ray-O-Vac Corp<br>Madison, Wisconsin   | 80183<br>Sprague Products<br>(Now 56289)  |
| 72228<br>AMCA International Corp.<br>Continental Screw Div.<br>New Bedford, Massachusetts | 73905<br>FL Industries Inc.<br>San Jose, California                                 | 77638<br>General Instrument Corp.<br>Rectifier Div.<br>Brooklyn, New York             | 80294<br>Bouns Instruments Inc.<br>Riverside, California  |
| 72259<br>Nytronics Inc.<br>New York, New York   | 73949<br>Guardian Electric Mfg. Co.<br>Chicago, Illinois                            | 77900<br>Shakeproof Lock Washer Co.<br>(Now 78189)                                    | 80583<br>Hammerlund Mfg. Co. Inc.<br>Paramus, New Jersey  |
| 72619<br>Amperex Electronic Corp.<br>Dialight Div.<br>Brooklyn, New York                  | 74199<br>Quam Nichols Co.<br>Chicago, Illinois                                      | 77969<br>Rubbercraft Corp. of CA Ltd.<br>Torrance, California                         | 80640<br>Computer Products Inc.<br>Stevens-Arnold Div.<br>South Boston, Mass.                                       |
| 72653<br>G C Electronics Co.<br>Div. of Hydrometals Inc.<br>Rockford, Illinois            | 74217<br>Radio Switch Co.<br>Marlboro, New Jersey                                   | 78189<br>Illinois Tool Works Inc.<br>Shakeproof Div.<br>Elgin, Illinois               | 81073<br>Grayhill Inc.<br>La Grange, Illinois   |
| 72794<br>Dzus Fastner Co. Inc.<br>West Islip, New York                                    | 74306<br>Piezo Crystal Co.<br>Div. of PPA Industries Inc.<br>Carlisle, Pennsylvania | 78277<br>Sigma Instruments Inc.<br>South Braintree, Mass.                             | 81312<br>Litton Systems Inc.<br>Winchester Electronics Div.<br>Watertown, Connecticut                               |
| 72928<br>Gulton Industries Inc.<br>Gudeman Div.<br>Chicago, Illinois                      | 74542<br>Hoyt Elect.Instr. Works Inc.<br>Penacook, New Hampshire                    | 78290<br>Struthers Dunn Inc.<br>Pitman, New Jersey                                    | 81439<br>Therm-O-Disc Inc.<br>Mansfield, Ohio   |
| 72982<br>Murata Erie N. America Inc.<br>Erie, Pennsylvania                                | 74840<br>Illinois Capacitor Inc.<br>Lincolnwood, Illinois                           | 78553<br>Eaton Corp.<br>Engineered Fastener Div.<br>Cleveland, Ohio                   | 81483<br>International Rectifier Corp.<br>Los Angeles, California   |
| 73138<br>Beckman Industrial corp.<br>Helipot Div.<br>Fullerton, California                | 74970<br>Johnson EF Co.<br>Waseca, Minnesota  | 78592<br>Stoeger Industries<br>South Hackensack, New Jersey                           | 81590<br>Korry Electronics Inc.<br>Seattle, Washington  |
| 73168<br>Fenwal Inc.<br>Ashland, Massachusetts  | 75042<br>TRW Inc.<br>IRC Fixed Resistors<br>Philadelphia, Pennsylvania              | 79136<br>Waldes Kohinoor Inc.<br>Long Island City, New York                           | 81741<br>Chicago Lock Co.<br>Chicago, Illinois  |
| 73293<br>Hughes Aircraft Co.<br>Electron Dynamics Div.<br>Torrance, California            | 75297<br>Litton Systems<br>Kester Solder Div.<br>Chicago, Illinois                  | 79497<br>Western Rubber Co.<br>Goshen, Indiana  | 82227<br>Aipax Corp.<br>Cheshire Div.<br>Cheshire, Connecticut  |
|   | 75376<br>Kurz-Kasch Inc.<br>Dayton, Ohio  |   | 82240<br>Simmons Fastner Corp.<br>Albany, New York  |

# Federal Supply Codes for Manufacturers (cont)

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|---|--|--|---|
| 82305<br>Palmer Electronics Corp.<br>South Gate, California                             | 84171<br>Arco Electronics<br>Commack, New York                                       | 89536<br>John Fluke Mfg. Co., Inc.<br>Everett, Washington                                    | 91802<br>Industrial Devices Inc.<br>Edgewater, New Jersey                                   |
| 82389<br>Switchcraft Inc.<br>Sub of Raytheon Co.<br>Chicago, Illinois                   | 84411<br>American Shizuka<br>TRW Capacitors Div.<br>Ogallala, Nebraska               | 89597<br>Fredericks Co.<br>Huntingdon Valley, Penna.   | 91833<br>Keystone Electronics Corp.<br>New York, New York                                   |
| 82415<br>Airpax Corp.<br>Frederick Div.<br>Frederick, Maryland                          | 84613<br>FIC Corp.<br>Rockville, Maryland  | 89709<br>Bunker Ramo-Eltra Corp.<br>Amphenol Div.<br>Broadview, Illinois                     | 91836<br>King's Electronics Co. Inc.<br>Tuckahoe, New York                                  |
| 82872<br>Roanwell Corp.<br>New York, New York   | 84682<br>Essex Group Inc.<br>Peabody, Massachusetts                                  | 89730<br>General Electric<br>Lamp Div.<br>Newark, New Jersey                                 | 91929<br>Honeywell Inc.<br>Micro Switch Div.<br>Freeport, Illinois                          |
| 82877<br>Rotron Inc.<br>Custom Div.<br>Woodstock, New York                              | 85367<br>Bearing Distributing Co.<br>San Francisco, California                       | 90201<br>Mallory Capacitor Co.<br>Sub of Emhart Industries Inc.<br>Indianapolis, Indiana     | 91934<br>Miller Electric Co.<br>Woonsocket, Rhode Island                                    |
| 82879<br>ITT<br>Royal Electric Div.<br>Pawtucket, Rhode Island                          | 85372<br>Bearing Sales Co.<br>Los Angeles, California                                | 90215<br>Best Stamp & Mfg. Co.<br>Kansas City, Missouri                                      | 91984<br>Maida Development Co.<br>Hampton, Virginia   |
| 83003<br>Varo Inc.<br>Garland, Texas  | 85480<br>W. H. Brady Co.<br>Industrial Product<br>Milwaukee, Wisconsin               | 90303<br>Duracell Inc.<br>Technical Sales & Marketing<br>Bethel, Connecticut                 | 91985<br>Norwalk Valve Co.<br>S. Norwalk, Connecticut                                       |
| 83014<br>Hartwell Corp.<br>Placentia, California  | 85932<br>Electro Film Inc.<br>Valencia, California                                   | 91094<br>Essex Group Inc.<br>Suflex/IWP Div.<br>Newmarket, New Hampshire                     | 92914<br>Alpha Wire Corp.<br>Elizabeth, New Jersey  |
| 83055<br>Signalite Fuse Co.<br>(Now 71744)  | 86577<br>Precision Metal Products Co.<br>Peabody, Massachusetts                      | 91247<br>Illinois Transformer Co.<br>Chicago, Illinois                                       | 93332<br>Sylvania Electric Products<br>Semiconductor Products Div.<br>Woburn, Massachusetts |
| 83058<br>TRW Assemblies & Fasteners Group<br>Fasteners Div.<br>Cambridge, Massachusetts | 86684<br>Radio Corp. of America<br>(Now 54590)                                       | 91293<br>Johanson Mfg. Co.<br>Boonton, New Jersey  | 94144<br>Raytheon Co.<br>Microwave & Power Tube Div.<br>Quincy, Massachusetts               |
| 83259<br>Parker-Hannifin Corp.<br>O-Seal Div.<br>Culver City, California                | 86928<br>Seastrom Mfg. Co. Inc.<br>Glendale, California                              | 91462<br>Alpha Industries Inc.<br>Logansport, Indiana  | 94222<br>Southco Inc.<br>Concordville, Pennsylvania   |
| 83298<br>Bendix Corp.<br>Electric & Fluid Power Div.<br>Eatonville, New Jersey          | 87034<br>Illuminated Products Inc.<br>(Now 76854)                                    | 91502<br>Associated Machine<br>Santa Clara, California                                       | 94988<br>Wagner Electric Corp.<br>Sub of McGraw-Edison Co.<br>Whippany, New Jersey          |
| 83315<br>Hubbell Corp.<br>Mundelein, Illinois   | 88219<br>GNB Inc.<br>Industrial Battery Div.<br>Langhorne, Pennsylvania              | 91506<br>Augat Inc.<br>Attleboro, Massachusetts  | 95146<br>Alco Electronic Products Inc.<br>Switch Div.<br>North Andover, Massachusetts       |
| 83330<br>Kulka Smith Inc.<br>A North American Philips Co.<br>Manasquan, New Jersey      | 88245<br>Winchester Electronics<br>Litton Systems-Useco Div.<br>Van Nuys, California | 91507<br>Froeliger Machine Tool Co.<br>Stockton, California                                  | 95263<br>Leecraft Mfg. Co.<br>Long Island City, New York                                    |
| 83478<br>Rubbercraft Corp. of America<br>West Haven, Connecticut                        | 88486<br>Triangle PWC Inc.<br>Jewett City, Connecticut                               | 91637<br>Dale Electronics Inc.<br>Columbus, Nebraska   | 95275<br>Vitramon Inc.<br>Bridgeport, Connecticut   |
| 83553<br>Associated Spring Barnes Group<br>Gardena, California                          | 88690<br>Essex Group Inc.<br>Wire Assembly Div.<br>Dearborn, Michigan                | 91662<br>Elco Corp.<br>A Gulf Western Mfg. Co.<br>Connector Div.<br>Huntingdon, Pennsylvania | 95303<br>RCA Corp.<br>Receiving Tube Div.<br>Cincinnati, Ohio                               |
| 83740<br>Union Carbide Corp.<br>Battery Products Div.<br>Danbury, Connecticut           | 89020<br>Amerace Corp.<br>Buchanan Crimptool Products Div.<br>Union, New Jersey      | 91737<br>ITT Cannon/Gremar<br>(Now 08718)  | 95348<br>Gordo's Corp.<br>Bloomfield, New Jersey  |
|   | 89265<br>Potter-Brumfield<br>(See 77342)   |  | 95354<br>Methode Mfg. Corp.<br>Rolling Meadows, Illinois                                    |

# Federal Supply Codes for Manufacturers (cont)

95573  
Campion Laboratories Inc.  
Detroit, Michigan

95712  
Bendix Corp.  
Electrical Comp. Div.  
Franklin, Indiana

95987  
Weckesser Co. Inc.  
(Now 85480)

96733  
SFE Technologies  
San Fernando, California

96853  
Gulton Industries Inc.  
Measurement & Controls Div.  
Manchester, New Hampshire

96881  
Thomson Industries Inc.  
Port Washington, New York

97525  
EECO Inc.  
Santa Ana, California

97540  
Whitchell Electronics Corp.  
Master Mobile Mounts Div.  
Fort Meyers, Florida

97913  
Industrial Electronic  
Hardware Corp.  
New York, New York

97945  
Pennwalt Corp.  
SS White Industrial Products  
Piscataway, New Jersey

97966  
CBS  
Electronic Div.  
Danvers, Massachusetts

98094  
Machlett Laboratories Inc.  
Santa Barbara, California

98159  
Rubber-Tech Inc.  
Gardena, California

98278  
Malco A Microdot Co.  
South Pasadena, California

98291  
Sealectro Corp.  
BICC Electronics  
Trumbull, Connecticut

98372  
Royal Industries Inc.(Now 62793)

98388  
Lear Siegler Inc.  
Accurate Products Div.  
San Deigo, California

99120  
Plastic Capacitors Inc.  
Chicago, Illinois

99217  
Bell Industries Inc.  
Elect. Distributor Div.  
Sunnyvale, California

99378  
ATLIFE of Delaware Inc.  
N. Andover, Massachusetts

99392  
Mepco/Electra Inc.  
Roxboro Div.  
Roxboro, North Carolina

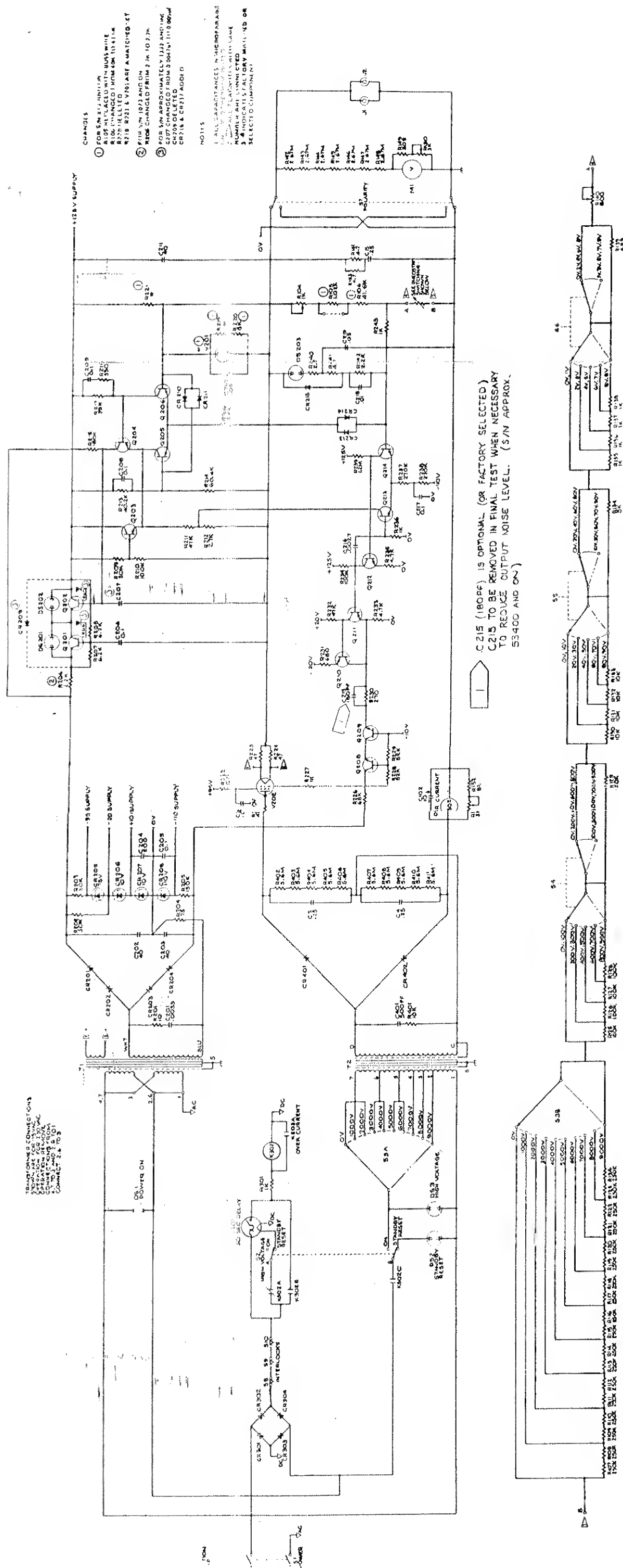
99515  
Electron Products Inc.  
Div. of American Capacitors  
Duarte, California

99779  
Bunker Ramo- Eltra Corp.  
Barnes Div.  
Lansdown, Pennsylvania

99800  
American Precision Industries  
Delevan Div.  
East Aurora, New York

99942  
Mepco/Centralab  
A North American Philips Co.  
Milwaukee, Wisconsin







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## AL, Huntsville

John Fluke Mfg. Co., Inc.  
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Huntsville, AL 35805-6202  
(205) 837-0581

## AZ, Phoenix

John Fluke Mfg. Co., Inc.  
2211 S. 48th Street  
Suite B  
Tempe, AZ 85282  
(602) 438-8314

## Tucson

(602) 790-9881

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John Fluke Mfg. Co., Inc.  
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16969 Von Karman  
Suite 100  
Irvine, CA 92714  
(714) 863-9031

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2020 N. Lincoln Street  
Burbank, CA 91504  
(213) 849-7181

## Northern

John Fluke Mfg. Co., Inc.  
2300 Walsh Ave., Bldg. K  
Santa Clara, CA 95051  
(408) 727-0513

## San Diego

(619) 292-7656

## CO, Denver

John Fluke Mfg. Co., Inc.  
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Aurora, CO 80014  
(303) 695-1000

## CT, Hartford

John Fluke Mfg. Co., Inc.  
Glen Locken East  
41-C New London Turnpike  
Glastonbury, CT 06033  
(203) 659-3541

## DC, Washington

(301) 770-1570

## FL, Clearwater

(813) 799-0087

## Miami

(305) 462-1380

## Orlando

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Orlando, FL 32803  
(305) 896-4881

## Tampa

(813) 251-9211

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## IN, Indianapolis

John Fluke Mfg. Co., Inc.  
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Suite 101  
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(317) 875-7870

## LA, Baton Rouge

(504) 924-1203

## New Orleans

(504) 455-0814

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Livonia, MI 48150  
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## MN, Bloomington

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## MO, St. Louis

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## NC, Greensboro

John Fluke Mfg. Co., Inc.  
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(919) 273-1918

## NJ, Paramus

John Fluke Mfg. Co., Inc.  
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West 75 Century Road  
Paramus, NJ 07652  
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## NM, Albuquerque

(505) 881-3550

## NY, Rochester

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## OR, Portland

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## TX, Austin

(512) 459-3344

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## El Paso

(915) 533-3508

## Houston

(713) 240-5995

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(203) 837-0581, AL

Navy (714) 863-9031, CA  
(301) 770-1570, MD

USAF (513) 436-2224, OH  
(512) 340-2621, TX

Security (301) 770-1570, MD

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CO, Denver (303) 695-1000  
FL, Orlando (305) 896-4881  
IL, Chicago (312) 705-0500  
MD, Rockville (301) 770-1576  
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TX, Dallas (214) 869-2848  
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Fluke (Holland) B.V., P.O. Box 2269, 5600 CG, Eindhoven, The Netherlands. Phone (040) 458045  
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Sofit Snophouse Complex  
Mile 1 Jalan Tutong  
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TLX: (953) 3161458 HSPL IN

New Delhi Service  
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New Delhi: 110 017, India  
Tel: 91 011 6433675

Cable: Tekcentre Delhi  
Hyderabad Office  
Hinditron Services Pvt. Ltd.  
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Litho in U.S.A. 11/87

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